Ecosystem Classification and Interpretation of the Sub-Boreal Spruce Zone, Prince Rupert Forest Region, British Columbia

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TABLE OF CONTENTS

Page

1.0 INTRODUCTION.......... 1

2.0 OBJECTIVES.......... 4

3.0 PRINCIPLES AND PHILOSOPHY.......... 5
3.1 Ecosystem.......... 5
3.2 Zonal Ecosystem.......... 8
3.3 Climax and Succession.......... 9
3.3.1 Climax.......... 9
3.3.2 Types of climax.......... 10
3.3.3 Succession.......... 11
3.3.4 Sub-boreal climax and succession.......... 11
3.3.5 Potential climax and succession.......... 12
3.4 Ecosystem Levels of Classification.......... 13
3.4.1 Ecosystem type.......... 14
3.4.2 Ecosystem association.......... 14
3.4.3 Ecosystem subassociation.......... 16
3.4.4 Ecosystem association phase.......... 17
3.5 Biogeoclimatic Levels of Classification.......... 18
3.5.1 Biogeoclimatic subzone.......... 19
3.5.2 Biogeoclimatic variant.......... 19
3.5.3 Biogeoclimatic phase.......... 20
3.5.4 Biogeoclimatic zone.......... 21

4.0 METHODS.......... 21
4.1 Plot Sampling.......... 23
4.2 Analysis.......... 24
4.3 Mapping.......... 28

5.0 STUDY AREA.......... 28
5.1 Physiography.......... 29
5.2 Surficial Deposits.......... 32
5.2.1 Glacial till.......... 33
5.2.2 Glaciofluvial deposits.......... 35
5.2.3 Glaciolacustrine deposits.......... 36
5.2.4 Fluvial deposits.......... 36
5.2.5 Colluvial deposits.......... 36
5.2.6 Organic deposits.......... 37
5.3 Bedrock Geology.......... 37
5.4 Climate.......... 38
5.4.1 General.......... 38
5.4.2 Sub-boreal climate.......... 40
5.5 Vegetation.......... 44
5.5.1 Upland forest.......... 44
5.5.2 Wetlands.......... 45
5.5.3 Aquatic vegetation.......... 46
5.5.4 Grassland and scrub.......... 46

5.6 Soils.......... 46
  5.6.1 Soils developed on glacial till.......... 47
  5.6.2 Soils developed on glaciofluvial deposits.......... 48
  5.6.3 Soils developed on fluvial deposits.......... 48
  5.6.4 Soils developed on colluvial deposits.......... 49
  5.6.5 Organic soils.......... 49
  5.6.6 Organic matter accumulation in mineral soils.......... 49
  5.6.7 Humus.......... 50

6.0 MODIFYING FACTORS.......... 50
  6.1 Settlement.......... 50
  6.2 Roads.......... 53
  6.3 Hydroelectric Development.......... 54
  6.4 Grazing.......... 54
  6.5 Logging.......... 55
  6.6 Fire.......... 57

7.0 SUB-BOREAL SPRUCE ZONE.......... 58
  7.1 Subzones.......... 58
    7.1.1 SBSa (Pine - spruce subzone).......... 59
      7.1.1.1 Ecological features.......... 59
      7.1.1.2 Silvicultural considerations.......... 64
    7.1.2 SBSd (Spruce subzone).......... 66
      7.1.2.1 Regional setting.......... 66
      7.1.2.2 Climate.......... 66
      7.1.2.3 Vegetation.......... 67
      7.1.2.4 Soils.......... 70
    7.1.3 SBSe (Subalpine fir subzone).......... 71
      7.1.3.1 Regional setting.......... 71
      7.1.3.2 Climate.......... 71
      7.1.3.3 Vegetation.......... 72
      7.1.3.4 Soils.......... 74

8.0 ECOSYSTEM UNITS OF THE SUB-BOREAL SPRUCE ZONE.......... 75
  8.1 Introduction and Definitions.......... 75
    8.1.1 General description page.......... 75
    8.1.2 Vegetation page.......... 80
    8.1.3 Soils page.......... 82
  8.2 Ecosystem Units of the SBSd: Spruce Subzone.......... 85
    SBSd/01 Mesic rose - peavine - moss ecosystem association.... 87
    SBSd/01(a) Mesic rose - peavine - moss ecosystem association: Coarse textured phase.......... 89
    SBSd/01(b) Mesic rose - peavine - moss ecosystem associaton: Fine textured phase.......... 90
    SBSd/01 Mesic rose - peavine - moss ecosystem association: Aspen-dominated seral stages.......... 96
    SBSd/02 Pine - lichen ecosystem association.......... 97
    SBSd/03 Pine - lichen - moss ecosystem association.......... 101
    SBSd/04 Saskatoon - wheatgrass scrub/steppe ecosystem association.......... 105

SBSd/05 Grassland ecosystems.. 110
SBSd/06 Douglas-fir - soopolallie ecosystem association....... 115
SBSd/07 Submesic bunchberry - moss ecosystem association...... 120
SBSd/08 Moist shrub - forb ecosystem association.............. 125
SBSd/09 Spruce - horsetail ecosystem association.............. 132
SBSd/09(a) Spruce - horsetail ecosystem association: Fluvial phase.. 135
SBSd/09(b) Spruce - horsetail ecosystem association: Lacustrine phase.. 136
SBSd/10 Cottonwood bottomland ecosystem associaton............ 140
8.2.1 Wetlands.. 144
SBSd/11 Swamp ecosystems.. 148
SBSd/12 Bog ecosystems.. 152
8.3 Ecosystem Units of the SBSel: Subalpine Fir Subzone, Western Variant.. 156
SBSel/01 Mesic bunchberry - moss ecosystem association......... 158
SBSel/01.1 Mesic bunchberry - moss: Black huckleberry subassociation.. 161
SBSel/01.1(a) Mesic bunchberry - moss, Black huckleberry subassociation: Coarse textured phase.................... 162
SBSel/01.1(b) Mesic bunchberry - moss, Black huckleberry subassociation: Fine textured phase...................... 163
SBSel/01.1 Mesic bunchberry - moss, Black huckleberry subassociation: Pine - aspen - forb stages.............. 175
SBSel/01.2 Mesic bunchberry - moss: Five-leaved bramble subassociation.. 165
SBSel/01.2(a) Mesic bunchberry - moss, Five-leaved bramble subassociation: Coarse textured phase................. 167
SBSel/01.2(b) Mesic bunchberry - moss, Five-leaved bramble subassociation: Fine textured phase................... 169
SBSel/01.2 Mesic bunchberry - moss, Five-leaved bramble subassociation: Aspen - shrub - forb stages............. 175
SBSel/02 Pine - lichen ecosystem association.................. 177
SBSel/03 Pine - moss ecosystem association.................... 181
SBSel/03(a) Pine - moss ecosystem association: Coarse textured phase.. 183
SBSel/03(b) Pine - moss ecosystem association: Lithic phase.... 184
SBSel/04 Submesic bunchberry - moss ecosystem association...... 187
SBSel/04(a) Submesic bunchberry - moss ecosystem association: Coarse textured phase............................... 189
SBSel/04(b) Submesic bunchberry - moss ecosystem association: Fine textured phase................................. 190
SBSel/05 Pine - black spruce ecosystem association............ 194
SBSel/06 Moist thimbleberry - forb ecosystem association....... 199
SBSel/07 Oak fern ecosystem association....................... 204
SBSel/07(a) Oak fern ecosystem association: Coarse textured phase.. 206
SBSel/07(b) Oak fern ecosystem association: Fine textured phase.. 207

SBSel/08 Devil's club ecosystem association.................... 211
SBSel/08(a) Devil's club ecosystem association: Coarse textured phase.. 213
SBSel/08(b) Devil's club ecosystem association: Fine textured phase.. 214
SBSel/09 Horsetail flat ecosystem association.................. 218
SBSel/09(a) Horsetail flat ecosystem association: Coarse textured phase.. 220
SBSel/09(b) Horsetail flat ecosystem association: Fine textured phase.. 221
SBSel/10 Black spruce fen and swamp ecosystems................. 225

9.0 SILVICULTURAL MANAGEMENT INTERPRETATIONS............................ 230
9.1 Introduction.. 230
9.2 Species Selection, Advanced Regeneration and Stock Type for Planting.. 233
9.2.1 Species selection.. 233
9.2.2 Advanced regeneration.. 233
9.2.3 Stock type for planting.. 235
9.3 Competing Vegetation.. 237
9.4 Site Preparation.. 241
9.4.1 Mechanical site preparation.................................... 242
9.4.2 Prescribed fire.. 246
9.4.3 Maintenance of site productivity............................... 248
9.4.4 Herbicides... 251
9.4.5 Livestock and domestic forages................................. 251
9.5 Insects and Disease... 252
9.6 Regeneration Systems.. 252
9.7 Growth Class, Basal Area and Volume by Ecosystem Association..... 254
9.8 Silvicultural Prescriptions.. 259
9.8.1 SBSd... 260
9.8.2 SBSel.. 261

10.0 LITERATURE CITED.. 297

APPENDIXES

Appendix Page

1 List of Plant Names Used in the Guide............................ 308
2 Tree Species Symbols... 312
3 Glossary... 313

FIGURES

Figure Page

1 Timber Supply Areas of the Prince Rupert Forest Region, British Columbia.. 3

2 Schematic relations between zonal and ecosystem levels of classification.. 7

3 Edatopic grid of ecological moisture and nutrient regimes....... 22

4 The Sub-Boreal Spruce Biogeoclimatic Zone of British Columbia... 30

5 Sub-Boreal Spruce subzones of the Prince Rupert Forest Region... 31

6 Soil textural triangle.. 84

7 Edatopic grid of ecological moisture and nutrient regimes - SBSd.. 86

8 Values of pH in the effective rooting zone of SBSd and el ecosystem associations.. 94

9 Edatopic grid of ecological moisture and nutrient regimes - SBSel.. 157

10 The relationship between classification, prescription, and management.. 232

TABLES

Table Page

1 Ecological moisture regime classes.. 25

2 Ecological nutrient regime characteristics.. 26

3 Climatic data for the three Sub-Boreal subzones in the Prince Rupert Forest Region.. 42

4 Ecological attributes of the three Sub-Boreal subzones in the Prince Rupert Forest Region.. 60

5 Synopsis of ecosystem units of the Sub-Boreal Spruce Zone, spruce subzone (SBSd).. 76

6 Synopsis of ecosystem units of the Sub-Boreal Spruce Zone, subalpine fir subzone, western variant (SBSel).. 77

Cont'd

TABLES (cont'd)

Table Page

7 Optimum size for stock commonly used in the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.............................. 237

8 Guidelines for stock type selection in the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.............................. 238

9 Common trees, shrubs, and herbs that compete with young coniferous trees in the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.. 239

10 Criteria for identification of sites subject to potential brush competition with conifers in the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.. 240

11 Summary of ecosystems with significant potential for brush competition with conifers in the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.. 243

12 Major insects and diseases of commercial tree species of the Sub-Boreal Spruce Zone, Prince Rupert Forest Region............ 253

13 Some mensurational statistics for the Sub-Boreal Spruce Zone, spruce subzone (SBSd) of the Prince Rupert Forest Region........ 255

14 Some mensurational statistics for the Sub-Boreal Spruce Zone, subalpine fir subzone, western variant (SBSel) of the Prince Rupert Forest Region.. 256

15 Height ranges of growth classes corresponding to mensurational data (Tables 13 and 14)...................................... 258

16 Summary of silvicultural prescriptions for the Sub-Boreal Spruce Zone, spruce subzone (SBSd) of the Prince Rupert Forest Region.. 260

17 Summary of silvicultural prescriptions for the Sub-Boreal Spruce Zone, subalpine fir subzone, western variant (SBSel) of the Prince Rupert Forest Region.. 261

1.0 INTRODUCTION

The British Columbia Ministry of Forests is currently developing an ecosystem classification of the forest and range land of the province. Our classification is based, with some modifications, on the biogeoclimatic system developed over the past thirty years by Dr. V.J. Krajina and his students at the University of British Columbia. The system incorporates primarily climate, soil, and vegetation data. The resulting biogeoclimatic classification provides a framework for forest and range management, as well as for scientific research.

This guide briefly outlines the principles and methods of the classification system, stressing the two primary areas of emphasis within the classification, the biogeoclimatic (zones, subzones) and the ecosystematic (ecosystem association and their phases and variations). We summarize the environmental characteristics of the Sub-Boreal Spruce Biogeoclimatic Zone (SBS) and three of its subzones, the SBSa or "pine - spruce" subzone, the SBSd or "spruce" subzone, and the SBSe or "subalpine fir" subzone. The classification of the SBSd and e at the ecosystematic level is then presented in detail.

An ecological classification can serve several purposes, depending on the needs and viewpoints of the users of the classification. The B.C. Ministry of Forests intends its classification to provide a framework for scientific research and resource management, to be used as a tool for scientists and resource managers responsible for maintaining or enchancing supplies of timber, forage, wildlife habitat, recreation, and water quantity and quality. All resources can be related to our ecosystem classification, but timber has priority within this Ministry. Because of this priority and also because of insufficient knowledge of other resources, we have developed primarily silvicultural interpretations, which are presented in the final section of the report. Use these prescriptions as a guide; they are not intended to be final or to be used in "cookbook" fashion. With time and increasing knowledge, we will amplify and modify the interpretations as required.

The area covered by this guide encompasses most of the lowland and mid-elevation forests of the southeastern part of the Prince Rupert Forest Region, including much of the Bulkley, Lakes, and Morice Timber Supply Areas (T.S.A.'s) (see Figs. 1 and 5).

We have included, in the pocket on the inside back cover, a map at 1:500,000 of the subzones of the Sub-Boreal Spruce Zone in the Prince Rupert Forest Region. Ultimately a map of all biogeoclimatic zones, subzones, and variants will be produced at a scale of 1:500,000 for the area covered by this report. The map will be similar to that produced by Klinka et al. (1979. Biogeoclimatic Units of Central and Southern Vancouver Island). Unfortunately we do not yet know enough of the study area (map sheets 93 S.W., 93 N.W., 94 S.W., 104 S.E.), especially at higher elevations, to make such a map.

The map pocket also contains simplified schematic diagrams of topographic relationships among the ecosystem associations of both the SBSd and e. As well, it includes an artist's (P. Sowden) impressions of the zonal ecosystems of both subzones.

We have also prepared a field guide to plants, entitled "Some Common plants of the Sub-Boreal Spruce Zone" (Pojar et al. 1982), and designed to be used in conjunction with this guide to classification and interpretation.

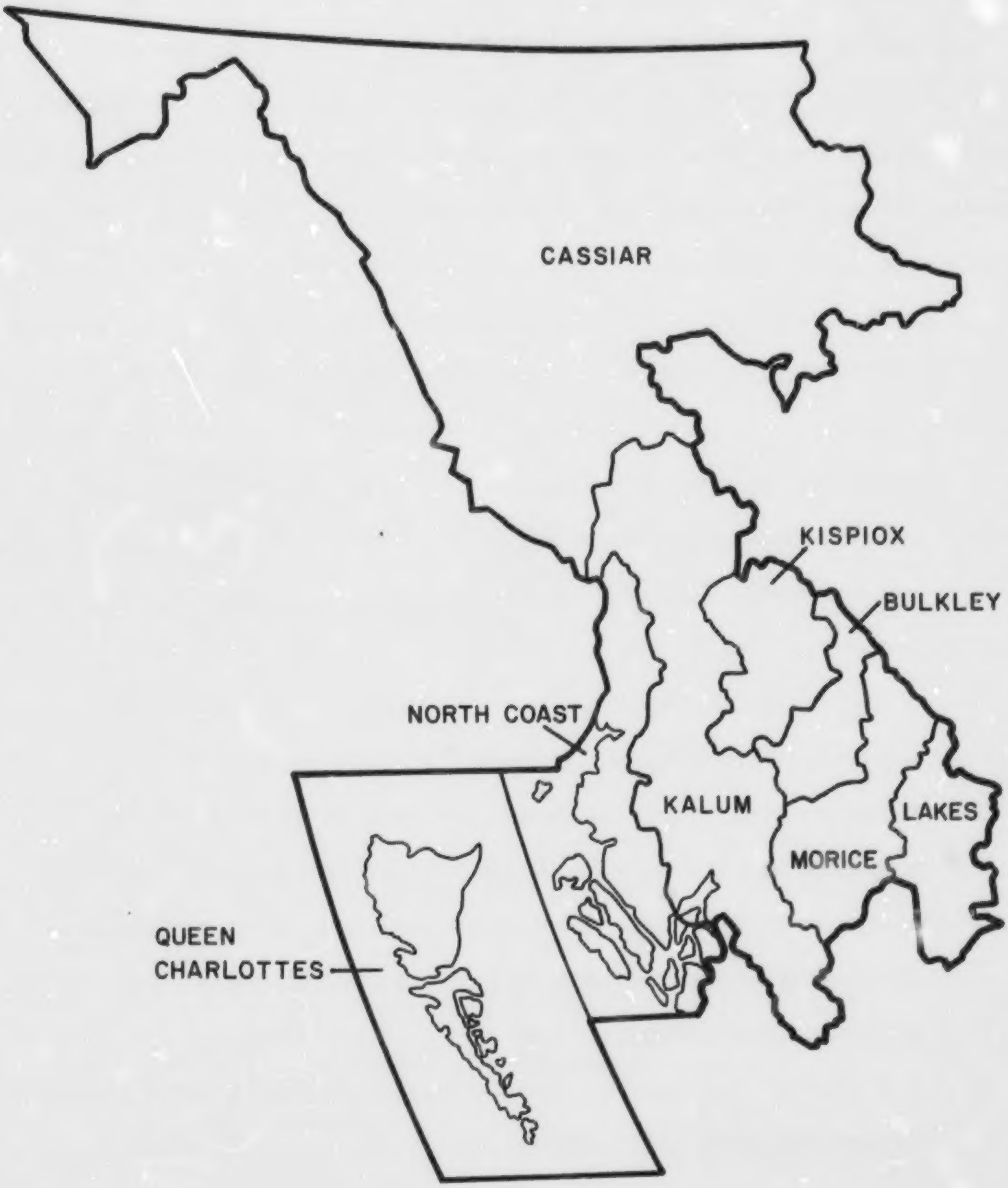
CASSIAR
KISPIOX
BULKLEY
NORTH COAST
KALUM
LAKES
MORICE
QUEEN CHARLOTTES

Figure 1. Timber Supply Areas of the Prince Rupert Forest Region, British Columbia.

2.0 OBJECTIVES

The goal of the ecosystem classification program is the improvement of forest management in B.C. The overall objective of the program is to provide resource managers with some of the tools to meet the goal, by developing a "permanent", land-based, ecological classification to organize our knowledge of ecosystems and to serve as a framework within which to manage resources. In other words, the classification program aims to both organize and apply our knowledge of the structure, function, and relationships of forest and range ecosystems.

More specifically, this guide has five objectives:

1. Characterization, description, and mapping of the Sub-Boreal Spruce Biogeoclimatic Zone and its subzones in the Prince Rupert Forest Region;
2. Characterization and description of forest ecosystems in the Sub-Boreal Spruce Zone;
3. Provision of aids in the identification of biogeoclimatic and ecosystematic units in the Sub-Boreal Spruce Zone;
4. Development of preliminary silvicultural and forest management interpretations and recommendations relating to the ecosystem units of the Sub-Boreal Spruce Zone;
5. Promotion of the concept of the ecosystem as the fundamental unit of forest management.

3.0 PRINCIPLES AND PHILOSOPHY

Numerous authors working in many different scientific fields have analysed and described the philosophy and methods of taxonomic classification. Some summaries pertinent to ecosystem classification are by Cline (1949), Whittaker (1962), Sokal (1974), Soil Survey Staff (1975), Bailey et al. (1978), Davis and Henderson (1978), and Pfister and Arno (1980). The biogeoclimatic system used by the Ministry of Forests is a classification of ecosystems (also called biogeocoenoses). It is being developed as a multi-level hierarchy with two primary sections or areas of emphasis: ecosystem or biogeocoenotic levels of integration, and biogeoclimatic or zonal levels (Fig. 2). Each section has several hierarchical taxonomic categories, as explained below in sections 3.4 and 3.5.

3.1 Ecosystem

Ecosystem is the term used for the sum total of vegetation, animals, and physical environment in whatever size segment of the world is chosen for study (Fosberg 1967). Ecosystems are interacting complexes of living organisms (plants, fungi, bacteria, animals) and the physical environment (soil, air, water, bedrock) immediately affecting them. The ecosystem, as defined by Tansley (1935), has long served as the fundamental conceptual and functional unit of ecology. However, Tansley's concept of ecosystem is too broad to easily integrate into a formal classification. Therefore, Krajina (1960) proposed that Sukachev's (Sukachev and Dylis 1964) biogeocoenose for practical purposes best represents a basic ecosystem. A biogeocoenose is a special case of the ecosystem, but the two terms are used here interchangeably. Hence, for our purposes a terrestrial ecosystem (biogeocoenose) is a unit or portion of the landscape and the life on and in it. It is a landscape segment relatively uniform in the composition, structure, and properties of both the biotic and abiotic environments and in their interactions.

Numerous organisms such as fungi, earthworms, bacteria, insects, birds, and mammals are as much a part of the forest ecosystem as are trees, shrubs, herbs, and mosses. Furthermore, within the ecosystem there is a complex and dynamic set of relationships among these organisms and between them and their physical environment. However, for simplicity the classification system deals primarily with two components of the ecosystem: vegetation and soil. The model of ecosystem function is that of Major (1951): vegetation and soils are products of climate, organisms, topography, parent material, and time. Plants and soil, considered simultaneously, integrate most ecosystem components and reflect ecosystem functioning. They are easy to observe and assess, and are considered to be the most convenient and suitable ecosystem features upon which to base the classification.

Thus, an ecosystem may be practically characterized by a 'plant community' (an area of relatively uniform vegetation) and the 'soil polypedon' (a volume, to the depth of the solum, of relatively uniform soil) upon which the plant community occurs. An ecosystem has geographical bounds; its size is determined by the extent of the plant community and the associated soil polypedon. The latter boundaries may be abrupt, but more commonly they are gradual. As a result, an individual ecosystem usually contains some variation in biotic and abiotic characteristics.

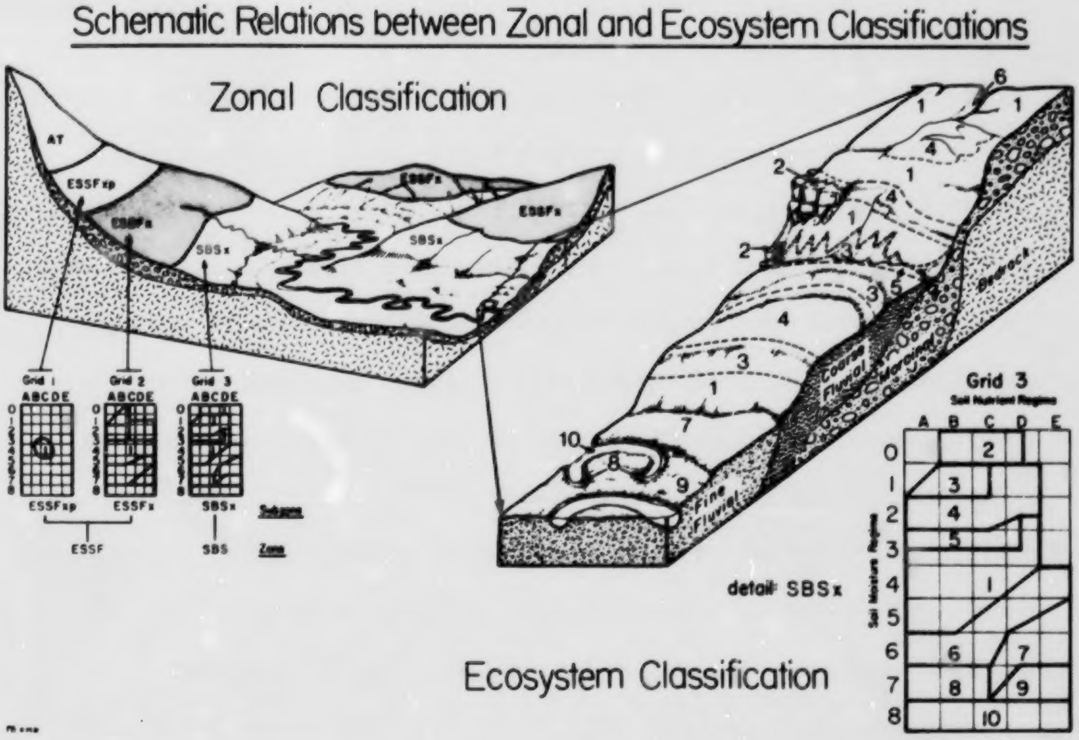
Schematic Relations between Zonal and Ecosystem Classifications
Zonal Classification
AT
ESSFxp
ESSFx
ESSFx
ESSFx
SBSx
SBSx
Grid 1
Grid 2
Grid 3
ABCDE
ESSFxp
ESSFx
SBSx
Subzone
ESSF
SBS
Zone
Coarse Fluvial
Moraine
Bedrock
Fine Fluvial
1
2
3
4
5
6
7
8
9
10
detail: SBSx
Grid 3
Soil Nutrient Regime
Soil Moisture Regime
A
B
C
D
E
0
1
2
3
4
5
6
7
8
Ecosystem Classification

Figure 2. Schematic relations between zonal and ecosystem levels of classification. AT = Alpine Tundra Zone; ESSFx and ESSFxp = hypothetical forested and parkland subzones, respectively, of the Engelmann Spruce - Subalpine Fir Zone; SBSx = a hypothetical subzone of the Sub-Boreal Spruce Zone.

3.2 Zonal Ecosystem

Climate is the fundamental determinant of the nature of terrestrial ecosystems. A classification of ecosystems should attempt to group related ecosystems influenced by the same 'mesoclimate'. However, climate data are scant or lacking in some areas and climatic analysis alone will not produce an ecosystem classification. A reliable functional link between climate and ecosystems is needed. The concept of the zonal or climatic climax ecosystem provides this link.

The zonal ecosystem is that which best reflects the mesoclimate or regional climate of an area. The integrated influence of climate on the vegetation, soil, and other ecosystem components is mostly strongly expressed in those ecosystems least influenced by local relief or by physical and chemical properties of soil parent materials. Such ecosystems generally occur on gentle to moderate (5% to 30%) slopes, in positions that neither receive nor shed an excess of water and nutrients. They have normal exposure to solar energy (heat and light) and wind, and are not affected by localized cold air drainage. Zonal ecosystems have intermediate soil textures (broadly loamy), medium or mesic moisture regimes, and medium or mesotrophic nutrient regimes[1]. Soils usually are moderately pervious, deep (greater than 1m), and without root- restricting layers within one meter or so of the surface. Hence, the biogeochemical cycles and energy exchange pathways of zonal ecosystems are less dependent on local relief and soil parent material than in other, nonzonal ecosystems, and are in equilibrium with the regional climate.

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[1] Mesic and mesotrophic are qualitative, relative terms that represent different actual conditions in different zones (e.g., a mesic ecosystem in the Sub-Boreal Spruce Zone is quantitatively drier than a mesic ecosystem in the Coastal Western Hemlock Zone). However, in all zones mesic and mesotrophic designate "average" or medium moisture and nutrient conditions, intermediate between the existing extremes of each zone.

Other ecosystems in a given area are influenced more strongly by local physiography and the physical and chemical properties of soil parent materials. They may be drier, wetter, richer, or poorer than zonal ecosystems, and they do not provide as clear a reflection of the regional climate.

Zonal ecosystems are characteristic of the regional climate that dominates their development. Hence, they are used to characterize biogeoclimatic units, which represent broad geographical areas of similar mesoclimate. The distribution of zonal ecosystems also determines the geographical extent of the biogeoclimatic units. Thus the concept of the zonal ecosystem links the ecosystematic and biogeoclimatic levels of classification (a zonal ecosystem labelled as 1, is indicated in Fig. 2).

3.3 Climax and Succession

3.3.1 Climax

The term climax in ecology refers to a condition of dynamic equilibrium, a steady state rather than a static endpoint. A climax ecosystem is in theory a stable, permanent occupant of the landscape, self-perpetuating unless disturbed by outside forces or modifying factors. The living components of a climax ecosystem are in equilibrium with the prevailing factors of the physical environment and the member species are in dynamic balance with one another.

In climax vegetation the plant community is self-maintaining. Tree species of a climax forest are present as germinants, seedlings, saplings, and subcanopy and canopy trees. Similarly, climax shrubs, herbs, mosses, liverworts, and lichens are present in all stages from seedling or sporeling to maturity. In zonal forest ecosystems, only tree species which tolerate shade and intermediate moisture and nutrient conditions regenerate continually under the forest canopy.

3.3.2 Types of climax

Climatic climax ecosystems reflect the development potential of the prevailing regional climate. Other types of climax ecosystems occur where certain environmental factors have a greater influence on ecosystem development than does the regional climate. An edaphic climax differs from the climatic climax due to extreme soil or substrate conditions such as very coarse texture, high base saturation, or poor drainage. A topographic climax reflects the effects of topography on local climate (e.g., such as increased insolation, radiant energy, and drainage on a steep south slope). A topoedaphic climax occurs as a result of the combined influence of soil and topography (e.g., shallow, stony soil on a steep south slope). A fire climax may result from recurrent wildfire.

3.3.3 Succession

Ecosystems arrive at climax through a process of change called ecological succession, the progressive development of ecosystems through time. Sequential series of successional stages are called seres. There are several recognizable seral or successional stages in ecosystem development from, for example, an original bare surface to a mature forest. In theory, succession ends in a mature, climax ecosystem.

3.3.4 Sub-boreal climax and succession

The reality of sub-boreal forest is a mosaic of microsites (or cover types) each of which may be in a different state of successional development. The entire system can be considered more or less stable and in dynamic balance with regional climate, especially when one perceives recurrent fire (the major pre-logging disturbance in sub-boreal regions) as an adjunct of sub-boreal climate. The various seral stages of sub-boreal forest would, with sufficient time and freedom from disturbance, mature to climax, but inasmuch as wildfire has been so frequent and widespread, it is perhaps more valid to think of the whole mosaic as a stable climax (cf. Wright 1974).

Because of the widespread effects of natural disturbances such as fire, the increasingly pervasive influence of logging disturbance, and the fact that most of our commercial forests will be managed as seral ecosystems, we have relied on forest stands 100 years or older for our field sampling. Any stand older than roughly 120-135 years we regard as climax in the Sub-Boreal Zone, even though such an ecosystem may contain species that cannot regenerate efficiently beneath their own canopy and would be expected to decline with time and further development towards the theoretical climax.

Seral ecosystems are widespread in the SBS. Especially abundant are fire-originated seral stands of aspen and/or pine that appear to belong to the zonal ecosystem associations. In part because our classification relies on climax ecosystems, seral ecosystems have not yet been formally integrated into the classification of the SBS. However, we have described some features of seral stages of the zonal e.a.s of both the SBSd and e. Seral variations of all other SBS associations also exist, but we have scarcely sampled them. This treatment of seral ecosystems is unsatisfactory but is the best we can do for the time being.

3.3.5 Potential climax and classification

British Columbia foresters will increasingly deal with seral ecosystems in the future, as older climax or near-climax stands are logged and replaced with young seral stands. Since our system classifies potential climax ecosystems, might not the classification become obsolete when managed seral forests prevail? No. IF logging- related disturbance is not excessive, the potential and limitations of a logged-over site remain similar to what was set out by the classification and interpretation of the original or potential climax ecosystem. The ecosystem remains in the clearcut, although in much altered form. Successional trends toward the climax can usually be identified even in young stands. We can still recognize, describe, and integrate the seral ecosystem into our classification, and can still make interpretations and predictions about the seral ecosystem throughout its succession towards harvestable age. Ecosystem classification thus provides a more or less permanent and ecologically-based system of land classification, with immediate and continuing application to management activities.

3.4 Ecosystem Levels of Classification

Classification at ecosystematic (or biogeocoenotic) levels involves small areas relatively homogeneous in vegetation, soils, and implicitly in patterns of nutrient and energy dynamics, whereas classification at biogeoclimatic levels involves broad geographical areas of similar climate.

In this report, we use the ecosystematic categories of ecosystem association, subassociation, and type. Phases of ecosystem associations are also recognized and used although the phase is not a formal category in the classification. We will go into some detail in defining ecosystematic units, as they represent the levels of the classification within which most of the users of this report will be working.

3.4.1 Ecosystem type

An individual ecosystem consists of a plant community plus the soil polypedon upon which the community occurs. In the Sub-Boreal Spruce Zone (SBS), the landscape is covered by numerous ecosystems of varying size, spread out over hill and valley. Most are forested; some are grassy, brushy, boggy, or have been recently cut or burned. Often the different ecosystems form a complex mosaic over the land, but their distribution is not random or helter-skelter. Similar plant communities recur in similar habitats, as do similar soil polypedons. The classification groups similar climax plant communities into 'plant associations', and similar (in terms of humus form, horizons, texture, reaction (pH), parent materials, rooting depth, and coarse fragments) soil polypedons into 'soil families'. We define an 'ecosystem type' as all ecosystems (land areas plus their biota) capable of producing vegetation belonging to the same climax plant association on soil of a single soil family.

3.4.2 Ecosystem association

We then define the 'ecosystem association' as all ecosystems capable of producing vegetation belonging to the same plant association at climax. Thus an ecosystem association is a group of related ecosystems physically and biologically similar enough that they have or would have similar vegetation at climax. The ecosystem association is similar to the habitat type of Daubenmire (1968) and Pfister et al. (1977).

We use the climax (or where necessary the advanced seral) condition to characterize ecosystem associations because we think that, as the culmination of ecological succession, the climax association best reflects the integration of environmental factors. One ecosystem association may include a variety of disturbance-induced, or seral, ecosystems, but succession will ultimately result in similar plant communities at climax throughout the association. Use of the climax plant association to name ecosystem associations does not imply that climax vegetation dominates the present landscape. Many ecosystems in the SBS reflect some form of disturbance and are in various stages of succession towards climax.

So at this level of the classification we utilize the vegetation to define the taxon of ecosystem association. Although such an approach risks over-simplification, its utility validates it to some extent; vegetation may be readily observed and described. Furthermore, plants integrate and reflect other ecosystematic factors (climate, nutrient and water levels, time, etc.); vegetation is a product as well as a part of the environment.

For these and reasons of brevity and familiarity we label the ecosystem association with the name of the climax plant association. For example, there is, in the Sub-Boreal Spruce Zone, the *Picea glauca* x *engelmannii*[1] - (*Abies lasiocarpa*) - *Lonicera involucrata* - *Equisetum* (*arvense*, *sylvaticum*, *pratense*) ecosystem association or, colloquially, Horsetail Flat (represented by area 9 in Fig. 2). Ideally, the name for this ecosystem unit would incorporate features of physiography and soils, but that would be impractical. But a reference to the Spruce - (subalpine fir) - Lonicera - Equisetum ecosystem association signifies that group of ecosystems that occur at the base of slopes or in depressional areas, over poorly to moderately drained fluvial, morainal, or lacustrine parent materials; that have developed Gleysols, Dystric Brunisols or Cumulic Regosols and Hydromoder or Mormoder humus forms[2]; that generally have an excess of soil water and an abundance of nutrients but often poor soil aeration; and that at climax develop vegetation that may be characterized by the Picea - (Abies) - Lonicera - Equisetum plant association. Providing the classification is adequately described, explained, and understood, a relatively simple name can convey a great deal of useful information about individual ecosystems in the field.

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[1] See page 75 for sources of botanical nomenclature.

3.4.3 Ecosystem subassociation

Some ecosystem variation appears to the scientist to be real and worthy of a place in the classification, but at the same time may be difficult to describe or delineate, and can be perceived more as trends or by qualitative attributes than by quantitative or clear-cut characters. In such cases we have chosen to designate

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[2] Humus form (forest floor) terminology by Klinka et al. (1981).

'ecosystem subassociations', taxonomic subdivisions of the ecosystem association which may or may not be present in any given area, and which may be difficult to recognize and segregate in the field. Further sampling and analysis may give them enough definition to warrant separate status as ecosystem associations, but for the time being we will use subassociations for the SBSe1/01, namely the Vaccinium membranaceum (SBSe1/01.1) and Rubus pedatus (SBSe1/01.2) subassociations. They usually can be recognized in the field on the presence/absence or relative abundance of Vaccinium and Rubus, and there are edaphic tendencies as well - the SBSe1/01.2 tends to occur on slightly moister and richer sites, on gentler terrain, and in more downslope positions than the SBSe1/01.1. But things are not always so straightforward and it seems best to use the subassociation level here.

3.4.4 Ecosystem association phase

Sometimes the ecosystem association, which is a fundamental theoretical unit in the classification, may also be the operational unit upon which to base silvicultural and other management decisions. For example, to make silvicultural prescriptions it may be enough for the forester to know that a sub-boreal site belongs to the Pine-lichen (area 2 in Fig. 2), or to the Horsetail Flat ecosystem association. However, in many cases the ecosystem association must be subdivided into more operationally significant units. This is especially true of those widespread ecosystem associations that encompass quite a range of habitat conditions.

The 'ecosystem association phase' (or ecosystem phase for short) is used for better site differentiation and identification. The 'ecosystem phase' is basically a functional subdivision of the ecosystem association (or subassociation) and recognizes some edaphic property or attribute that may be useful or significant to the users of the classification. For example, recognition of two general particle size classes (coarse and fine) as two phases of the SBSe1/01, or Mesic bunchberry - moss ecosystem association, gives much more meaning to silvicultural interpretations of this widespread unit. Other ecosystem phases might be based on slope classes, aspect, soil climate, bedrock type, or some other useful feature of the soil or landform. The ecosystem phase thus reflects variation contained within ecosystem associations (and subassociations), and allows differentiation of recognizable and repeatable subunits of the ecosystem association for management, silvicultural, or purely descriptive purposes.

3.5 Biogeoclimatic Levels of Classification

The biogeoclimatic area of emphasis provides higher categories in the taxonomic hierarchy to accommodate further generalization of ecosystem units, based mainly on climatic relationships. Classification, characterization, and mapping of biogeoclimatic units are the major activities carried out at these levels. Biogeoclimatic units or categories commonly used by the Ministry of Forests are the zone, subzone, and variant. In addition, phases are recognized and used, but the phase is not a formal category in the classification.

3.5.1 Biogeoclimatic subzone

A distinct climatic climax or zonal ecosystem association characterizes a 'subzone'. A subzone thus consists of unique sequences of geographically related ecosystems in which climatic climax ecosystems are members of the same zonal ecosystem association. Such sequences are influenced by one type of regional climate. Subzones are the basic units of biogeoclimatic classification, and are the first to be recognized in the classification process. Note that the two sections of the classification are linked through the fundamental relationship between the zonal ecosystem association and the subzone.

This report deals primarily with two subzones of the Sub-Boreal Spruce Zone, the SBSd or spruce subzone and the SBSe or subalpine fir subzone.

3.5.2 Biogeoclimatic variant

Subzones also contain considerable variation, for which we have provided the biogeoclimatic category of 'variant'. Variants reflect further differences in regional climate, and are generally recognized for areas that are drier, wetter, snowier, warmer, or colder than other areas in the subzone. These climatic differences result in corresponding differences in vegetation, soil, and ecosystem productivity. The differences in vegetation may be expressed as changes in the proportion and vigour of certain plant species, or differences in successional development or in the overall pattern of vegetation over the landscape. Differences in soils may be confined to the variation in intensity of certain soil-forming processes and not be markedly expressed in morphological features. Thus, variants are characterized by a distinct zonal ecosystem association plus a supplementary combination of environmental factors.

In the first edition of the Sub-Boreal Spruce Zone report we have recognized only one variant, the SBSe1, within the Prince Rupert Forest Region. Another variant, the SBSe2, is recognized in the Prince George Forest Region to the east. In the future as our knowledge of the Sub-Boreal Spruce Zone increases more variants may be differentiated in both the Prince George and Prince Rupert Forest Regions.

3.5.3 Biogeoclimatic phase

The 'biogeoclimatic phase' accomodates variation, resulting from local relief, in the regional climate of subzones and variants. Phases are useful in designating significant, extensive areas of ecosystems that are, for topographic or topoedaphic reasons, atypical for the regional climate. Examples might be extensive areas of grassland occurring only on steep, south slopes in an otherwise forested subzone; enclaves of apparently coastal forest on moist, northeastern slopes in an interior, continental subzone (e.g. stands of Tsuga heterophylla (western hemlock) in

Dockrill Creek); or valley-bottom, frost-pocket areas in mountainous terrain. The biogeoclimatic phase relates to local climate and hence is not a formal category in the classification, but phases can be identified and mapped for management or descriptive purposes.

3.5.4 Biogeoclimatic zone

We group subzones with affinities in climatic characteristics and zonal ecosystems into zones. We define a biogeoclimatic zone as a large geographic area with a broadly homogeneous mesoclimate. Consequently a zone has characteristic webs of energy flow and nutrient cycling, and typical patterns of vegetation and soil. We characterize zones by closely related, zonal ecosystem associations. Zones also have characteristic, prevailing soil-forming processes, and one or more typical, major, climax species of tree, shrub, herb, and/or moss. Zones are usually named by one or more of the dominant shade-tolerant tree species (the Alpine Tundra Zone is a self-explanatory exception) capable of self-regeneration in zonal ecosystems; a geographical modifier is often added to the name.

4.0 METHODS

Field procedures of the Ministry of Forests' classification program follow those outlined in detail in the manual by Walmsley et al. (1980). Analytic and synthetic methods have been described by Klinka et al. (1977, 1979), and are similar to those of Krajina and his students (e.g., Brooke et

			NUTRIENT REGIME				
			OLIGOTROPHIC	SUBMESOTROPHIC	MESOTROPHIC	PERMESOTROPHIC	SUBEUTROPHIC TO EUTROPHIC
			A	B	C	D	E
MOISTURE REGIME	VERY XERIC	0					
	XERIC	1					
	SUBXERIC	2					
	SUBMESIC	3					
	MESIC	4					
	SUBHYGRIC	5					
	HYGRIC	6					
	SUBHYDRIC	7					

Figure 3. Edatopic grid of ecological moisture and nutrient regimes.

al. 1970; Wali and Krajina 1973; Kojima and Krajina 1975). However it seems that our methods are still not well-understood and need further explanation.

4.1 Plot Sampling

Field sampling is stratified on the basis of biogeoclimatic units and ecological moisture and nutrient regimes. Based on reconnaissance and other available information, tentative biogeoclimatic units are often delineated prior to plot selection. An edatopic grid (Fig. 3) is used as an aid to stratification within each biogeoclimatic unit. We try to sample five or more plots representing each of the possible combinations of moisture and nutrients. Intensity of sampling varies according to the areal extent of the ecosystem, its apparent diversity, and its importance for forestry or range management. Sampling intensity also depends on available access, and on the nature and scale of the project.

We sample selectively. Sample plots are located in habitats that are as uniform as possible; heterogeneous, transitional, or disturbed sites are avoided. To date, most sampling has been confined to climax or near-climax ecosystems. Plots are located so as to represent particular combinations of moisture and nutrients (see Tables 1 & 2). Slope position, indicator plant species, relative tree growth, soil texture, seepage, and base status of parent materials, among other things, are used as clues to moisture and nutrient regimes. The professional judgement of experienced fieldworkers in selecting representative ecosystems is an important part of our approach.

The smallest unit of sampling in ecosystem studies is the "sample plot" (also termed 'sample plot' by Mueller-Dombois and Ellenberg (1974) for vegetation sampling, and termed 'pedon' by Soil Survey Staff (1975) for soil sampling). Plot size in forest stands is usually 400 - 500 m^2; plot shape is variable but usually square or rectangular. At each site, the standardized provincial site, soil, humus form, vegetation, and mensuration data sheets are completed, according to the procedures in Walmsley et al. (1980).

4.2 Analysis

The information collected from the sample plots must be analysed and integrated into a usable classification. To accomplish this we code vegetation and selected soil, physical, and mensurational data for tabulation by a computer program developed by Klinka and Phelps (Klinka et al. 1977). The program sorts, organizes, and presents these data; it does not perform any classification. This procedure aids in the traditional Braun-Blanquet method of classification by tabular analysis (see Mueller-Dombois and Ellenberg 1974), mainly by reducing manual procedures and transcription errors.

The program produces environment, vegetation, and vegetation summary tables. The classifier specifies the tentative ecosystem units, relying to a large extent on personal knowledge and judgement. The program summarizes environment and vegetation data according to the specified units. The summary vegetation table then presents species presence

Table 1. Ecological moisture regime classes.[1]

MOISTURE REGIME	DEFINING CHARACTERISTICS		FIELD RECOGNITION CHARACTERISTICS						
				SOIL PROPERTIES					
	DESCRIPTION	PRIMARY WATER SOURCE	SLOPE POSITION	TEXTURE	DRAINAGE	DEPTH TO IMPERMEABLE LAYER	SURFACE HUMUS DEPTH	AVAILABLE WATER STOR. CAP.	SLOPE GRADIENT
VERY XERIC	Water removed extremely rapidly in relation to supply; soil is moist for a negligible time after ppt.	precipitation	ridge crests shedding	very coarse (gravelly-s) abundant coarse fragments	very rapid	very shallow (<0.5m)	very shallow	extremely low	very steep (especially on south aspects)
XERIC	Water removed very rapidly in relation to supply; soil is moist for brief periods following ppt.	precipitation			rapid				
SUBXERIC	Water removed rapidly in relation to supply; soil is moist for short periods following ppt.	precipitation	upper slopes shedding	coarse to mod. coarse (LS-SL)mod. coarse fragments				very low	
SUBMESIC	Water removed easily in relation to supply; water available for moderately short periods following ppt.	precipitation precipitation			rapid to well	shallow (<1m)	shallow	low	steep moderate
MESIC	Water removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short period of the year. Available soil moisture reflects climatic inputs.	precipitation in moderately to fine-textured soils and limited seepage in coarse textured soils	mid-slope normal rolling to flat	moderate to fine (L-Sil) few coarse fragments	well to moderately well	moderately deep (1-2m)	moderately deep	moderate	
SUBHYGRIC	Water removed slowly enough to keep the soil wet for a significant part of the growing season; some temporary seepage and possibly mottling below 20 cm.	precipitation and seepage	lower slopes receiving	variable depending on seepage	moderately well to imperfect	deep (>2m)	deep	high	slight
HYGRIC	Water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage and mottling present; possibly weak gleying.	seepage			imperfect to poor	variable depending on seepage		variable depending on seepage	
SUBHYDRIC	Water removed slowly enough to keep the water table at or near the surface for most of the year; gleyed mineral or organic soils; permanent seepage less than 30 cm below the surface.	seepage or permanent water table		variable depending on seepage	poor to very poor		very deep		
HYDRIC	Water removed so slowly that the water table is at or above the soil surface all year; gleyed mineral or organic soils.	permanent water table	depressions receiving		very poor	variable depending on seepage		variable depending on seepage	flat

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[1] From Walmsley et al. (1980).

Table 2. Ecological nutrient regime characteristics[1]

	OLIGOTROPHIC A	SUBMESOTROPHIC B	MESOTROPHIC C	PERMESOTROPHIC D	EUTROPHIC E	HYPEREUTROPHIC F
DEFINITION	very poor nutritional status, very small supply of available nutrients	poor nutritional status, low supply of available nutrients	medium nutritional status, medium supply of available nutrients	rich nutritional status, plentiful supply of available nutrients	very rich nutritional status, abundant supply of nutrients	saline nutritional status, excess salt accumulations
BEDROCK SOURCE	granite	granodiorite	diorite	gabbro	peridotite	dunite--serpentine
	rhyolite	dacite	andesite	basalt		
	quartzite	quartz gneiss	garnet schist	biotite schist---slate	phyllite-marble	
	quartz sandstone	conglomerate	graywacke	argillite---shale---dolomite	limestone	gypsym---halite
TEXTURE	very coarse	coarse	medium	fine	very fine	variable
ORGANIC MATTER CONTENT	low	moderate		high		variable
HUMUS FORM	acid mors	mors and moders		moders and mulls		
SOIL REACTION	extremely acid to medium acid	medium acid to neutral		slightly acid to mildly alkaline		moderately to strongly alkaline
CATION EXCHANGE CAPACITY	low		moderate	high		variable
BASE SATURATION	low		moderate	high		variable
C/N RATIO	high		moderate	low		variable

[1] From Walmsley et al. (1980). Note that the presence of nutrient-rich seepage waters may compensate for other factors to create eutrophic conditions.

(frequency of occurrence in sample plots) and mean species significance (an estimate of both cover and abundance) for all plant species in all differentiated units. Successive rearrangements can be easily made.

The classifier generally groups plots by tentative biogeoclimatic unit and by estimated moisture/nutrient regime. The vegetation tables list species by stratum or layer (trees, shrubs, herbs, etc.) in order of presence and mean percent cover for each ecosystem unit. Plots or groups of plots that are floristically different may be separated or moved to another group. Plots that appear similar in moisture and nutrient regime are experimentally merged. Through this process of computer-assisted, experimental grouping, rearrangement, and refining of groups, the ecosystem associations are defined (cf. Poore 1962). Ecosystem associations may then be subdivided into subassociations, types, variations, or phases, often on the basis of edaphic factors as summarized by the environment tables. The degree of lumping or splitting among ecosystem units is largely a matter of personal judgement or, in the case of phases, of operational significance.

Zonal ecosystem associations characterize individual subzones. Subzones which are more similar to each other than they are to any other subzones are then grouped into biogeoclimatic zones. This last taxonomic decision has to date been largely subjective, based on the classifiers' concepts of mesoclimate, zonal ecosystem associations, allowable variation within a zone, and the precedent of Krajina (1965, 1973, 1979).

The Ministry of Forests has so far done little mathematical treatment of the data collected and summarized by the ecosystem classification program. However, there are plans for using ordination and other numerical techniques in the near future.

4.3 Mapping

Biogeoclimatic mapping begins with a review of available ecosystem classifications within or near the mapping area. Biogeoclimatic units are characterized and summarized in synopsis form. A draft map, based on physiography and the extrapolation of elevational limits, may be prepared. Field mapping is done along selected transects by ground and air survey. The ground survey includes brief descriptions (rapid reconnaissance) of vegetation and soils; special attention is paid to zonal ecosystems. Boundaries drawn in the field are based on the type and occurrence of zonal ecosystems, floristic combinations, and the distribution of azonal, edaphic climax ecosystems. Final boundaries are drawn after fieldwork and data analysis have been completed. Boundaries outside transects are extrapolated on the basis of elevation and physiography.

5.0 STUDY AREA

Much of central British Columbia falls within the Sub-Boreal Spruce Biogeoclimatic Zone (SBS) (Fig. 4). The SBS of the Prince Rupert Forest Region[1] occurs at lower and medium elevations east of the Coast Range between roughly 53.5^{0} and 57^{0} N. lat. (Fig. 5). The zone covers most of the interior lowland forests of the southern half of the Region. The SBS includes much of the combined area of the Lakes, Morice, Bulkley, eastern Kispiox, and northeastern Kalum Timber Supply Areas (Fig. 1) or alternatively of the Burns Lake, Houston, Smithers, Hazelton, and northeastern Terrace Forest Districts.

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[1] The Prince Rupert Forest Region is an administrative, not an ecological unit.

5.1 Physiography

Nearly all of the study area consists of the Nechako Plateau, with some western and northwestern extensions into the Hazelton and Skeena Mountains (Holland 1976).

The Nechako Plateau is an area of low relief, with great expanses of quite flat or gently rolling country, variously dissected. The plateau passes by rapid transition into the Hazelton Mountains to the north. The plateau was heavily glaciated, and numerous lakes, ranging in size from small ponds to lakes as big as Babine, are part of the legacy of the glaciers. The plateau surface ranges in elevation from 600 to 1500 m, but the SBS grades into subalpine forest above 900 to 1200 m.

The Hazelton and Skeena Mountains form part of Holland's (1976) Central Plateau and Mountain Area. The majority of the peaks of these mountains lie between 1900 and 2300 m. Relief is fairly high, with generally wide and drift-filled valleys lying between 600 and 1200 m.

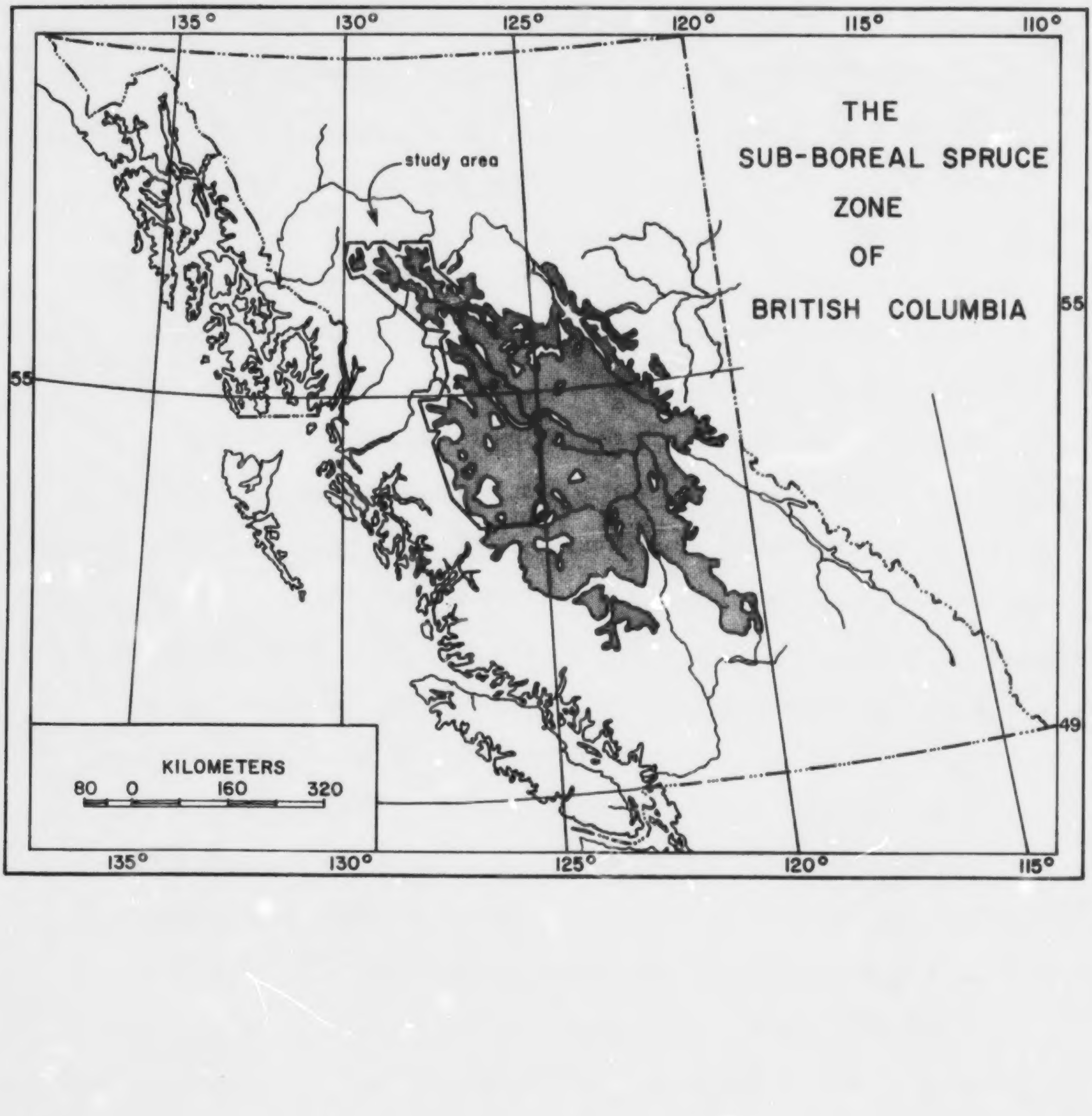

135°
130°
125°
120°
115°
110°
THE
SUB-BOREAL SPRUCE
ZONE
OF
BRITISH COLUMBIA
study area
55
55
49
KILOMETERS
80 0 160 320
135°
130°
125°
120°
115°

Figure 4. The Sub-Boreal Spruce Biogeoclimatic Zone of British Columbia.

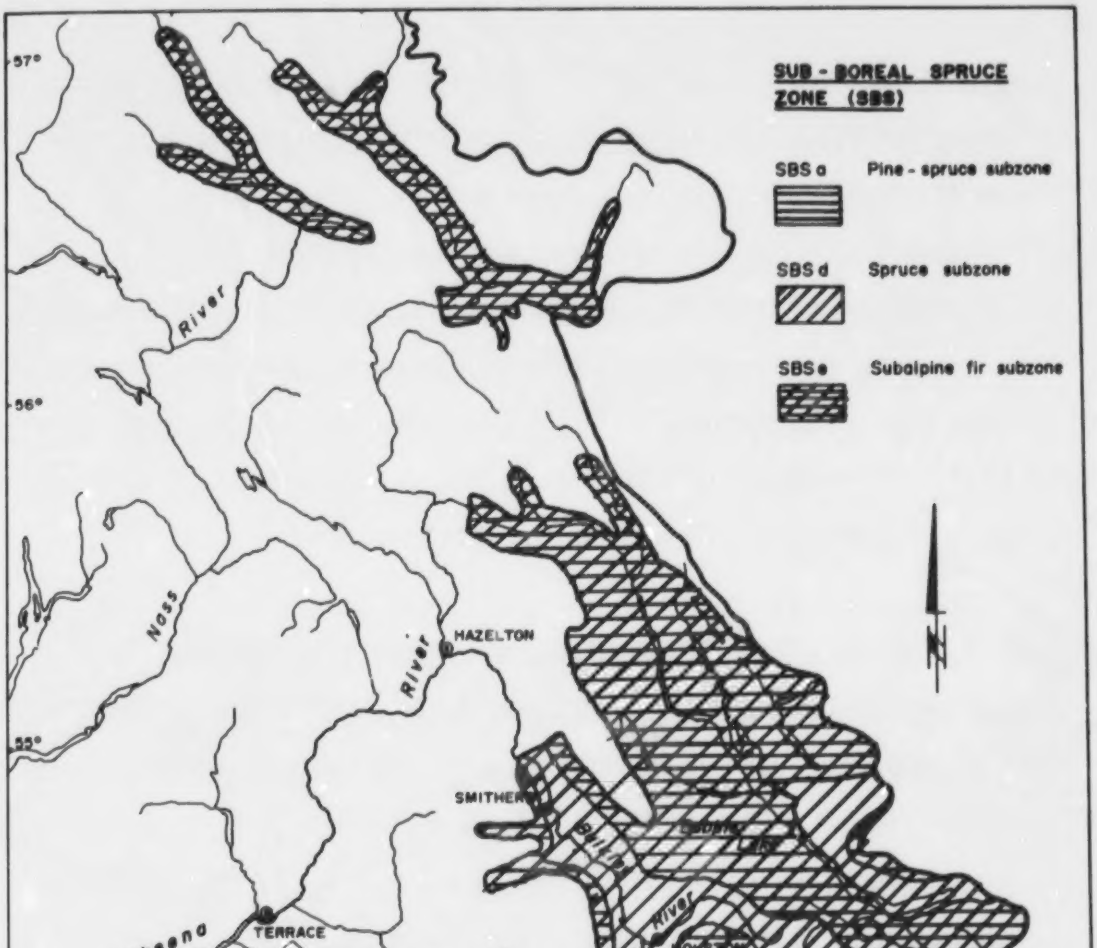

SUB-BOREAL SPRUCE ZONE (SBS)
SBS a Pine-spruce subzone
SBS d Spruce subzone
SBS e Subalpine fir subzone
57°
56°
55°
54°
River
Nass
River
HAZELTON
SMITHERS
Bulkley
River
Babine Lake
TERRACE
Skeena
129°
128°
127°
126°
125°
0
20
40
60
80
100
km
SCALE 1:1,900,800

Figure 5. Sub-Boreal Spruce subzones of the Prince Rupert Forest Region.

The Pleistocene ice sheet almost entirely covered the mountains and rounded their ridges and summits below 1800 m; valley glaciers have also modified valley profiles. In these mountains the SBS occurs in the valleys and on the lower mountain slopes up to 900-1100 m.

The SBS in the Prince Rupert region straddles the drainage divide between the Fraser and Skeena River systems. Major rivers in the study area include the Morice, Bulkley, Endako, Babine, Sustut, Skeena, and Nass. The largest lakes are Babine, Francois, Ootsa, and Eutsuk; all exert a moderating influence on the local climate.

5.2 Surficial Deposits (Armstrong and Tipper 1948; Howes 1977)

British Columbia has been subjected to multiple glaciations within the past two million years (Armstrong and Tipper 1948; Harington et al. 1974). However, most surficial materials in the Sub-Boreal Spruce Zone were produced during and since the Fraser Glaciation, the "last major glaciation of British Columbia" (Armstrong et al. 1965). The Fraser Glaciation commenced roughly 19,000 years ago, and ended about 10,000 years ago (Fulton 1971; Holland 1976; Howes 1977). During the height of this glaciation, a thick ice sheet covered all of the Nechako Plateau and most of the Hazelton, Skeena and Omineca Mountains (Armstrong and Tipper 1948; Holland 1976). Many drumlin-like ridges and grooves mark the surface of the plateau as evidence of ice movement. As the glacier advanced, it picked up material from the underlying bedrock and previous glacial deposits, and redeposited this material to form much of the parent material of our soils.

Glacial deposits '(drift)' that occur within the SBS include glacial till, glaciofluvial, and glaciolacustrine materials. Post-glacial modification of the glacial drift by running water has resulted in the formation of fluvial deposits in the valleys adjacent to rivers and streams. Colluvial deposits have developed on steep mountainous slopes since the Fraser Glaciation. Organic materials have also formed in recent time, from decomposed and decomposing plant material that has accumulated in depressions and moisture-receiving sites.

5.2.1 Glacial till

'Glacial till' mantles much of the SBS, especially the Nechako Plateau where till obscures a high percentage of the bedrock (Holland 1976). 'Morainal deposits' or till include both basal and ablation till.

Most of the 'basal till' (material deposited by ice without additional transportation by water) is an unsorted and unstratified mixture of sand, silt, clay, and coarser fragments. These materials are commonly relatively impervious and compacted at depth. Basal till is found over extensive areas of the Nechako Plateau and elsewhere in the SBS, and exists in a wide variety of textural composition. Post-glacial, gravity-induced movement of mountainous till or modification and transportation of deposits by glacial meltwater has improved the sorting of some till materials.

'Ablation till' was deposited when areas of stagnant/dead ice melted at slower rates than the surrounding ice mass. Such till is commonly found on north- and northeast-facing slopes and adjacent lowlands of the Nechako Plateau (Howes 1977), and in similar areas in the valleys of the Hazelton and Skeena Mountains. Areas of ablation till typically exhibit irregular, hummocky, and subdued topography with kettle holes; deranged drainage systems and associated organic deposits; and peripheral ice-contact glaciofluvial landforms radiating away from the area where ice probably stagnated (Howes 1977).

Glacial till (morainal) landforms in the SBS include low relief ground moraine, morainal veneers, morainal blankets, drumlins, and fluted landforms (cf. Howes 1977). 'Low relief ground moraine' occurs where bedrock exerts no control on the surface topography. Such terrain is common on the Nechako Plateau.

'Morainal veneers' and blankets are common throughout the SBS. Veneers (less than 1 m thick) occur upslope, on bedrock knobs, or in other locations where bedrock frequently outcrops. 'Morainal blankets' are thicker (greater than 1 m) deposits closely associated with long, smooth, bedrock-controlled slopes.

'Drumlins' are low, smooth, elongated, oval hills, mounds, or ridges of compact glacial till. They may consist entirely of till or have cores of bedrock. Drumlins are products of streamline flow of glaciers that molded the subglacial floor through a combination of erosion and deposition (Flint 1971). Their longer axes parallel the general direction of glacier flow; in our area eastward and northeastward in the Lakes District, southeastward along the Babine Lake valley (Holland 1976). Drumlinized terrain in the study area is similar to that to the east described by Armstrong and Tipper (1948).

'Fluted landforms' occur as areas of till that have surfaces of straight parallel grooves separated by ridges. Like the drumlins, they are aligned in the direction of Pleistocene ice movement. Howes (1977) points out that most of the till flutings appear to be the products of glacial erosion, but their origin is unknown.

5.2.2 Glaciofluvial deposits

'Glaciofluvial' or 'glacial outwash deposits' are the second most common type of surficial material in the SBS. These deposits occur in two general forms:

(a) Well-sorted, stratified sands and gravels deposited by meltwater streams in front of melting ice. Such deposits form 'proglacial outwash plains' that occur along the valley bottoms of the major rivers.

(b) Poorly sorted and stratified sands and gravels deposited by glacial meltwater in crevasses and tunnels beneath or along the margin of stagnant ice masses. 'Kames' and 'eskers' are two examples of such "ice-contacted" fluvioglacial landforms, and commonly occur along the sides and floors of valleys or on plateau surfaces throughout the SBS.

Kames, eskers, and outwash plains often constitute the driest, or most xeric, sites within the sub-boreal landscape.

5.2.3 Glaciolacustrine deposits

Proglacial lakes once occupied extensive areas in the vicinity of Fort St. James and Vanderhoof (Armstrong and Tipper 1948), but their 'glaciolacustrine' deposits extend into only a very small, easternmost part of the study area. Some minor glaciolacustrine deposits of well-sorted, compact silts and clays can also be found, particularly on the Nechako Plateau where small temporary lakes formed during deglaciation.

5.2.4 Fluvial deposits

'Fluvial' deposits are concentrated along the valley floors adjacent to the rivers and streams of the SBS. Major fluvial deposits occur along the Morice, Bulkley, Babine, Skeena, and Nass rivers. Fluvial landforms include fans, deltas, terraces and flood-plains. Fluvial sands and silts are often sorted and stratified.

5.2.5 Colluvial deposits

'Colluvial' deposits are unconsolidated materials deposited by mass wasting (direct gravitational action) on or at the base of steep slopes. The deposits usually consist of coarse, angular, fractured bedrock, but the bedrock fragments may also be mixed or associated with redistributed glacial till. Colluvial deposits have formed throughout the SBS wherever steep bedrock outcrops or mountains occur, and of course are much more abundant in the Hazelton and Skeena Mountains than on the Nechako Plateau.

5.2.6 Organic deposits

Organic materials have accumulated throughout the SBS in depressions of four types (Howes 1977):

(a) kettles associated with fluvioglacial landforms and ablation till;

(b) depressions within drumlinized or fluted terrain; and small basins in low relief ground moraine;

(c) bedrock hollows;

(d) minor depressions in level floodplain deposits, or old oxbow lakes.

Organic accumulation can also occur in moisture-receiving sites at the base of slopes, in gullies, etc.

5.3 Bedrock Geology (Holland 1976; Ryder 1978; Souther et al. 1979; Tipper et al. 1979)

Flat or gently dipping lava flows cover older volcanic and sedimentary (sandstone, siltstone) rocks over much of the Nechako Plateau. Granitic intrusions in the study area occur north and east of Burns Lake, in the vicinity of Endako, and on both sides of Babine Lake centred around Topley Landing. Most of the volcanic rocks of the Nechako Plateau erupted from fissures and shield volcanoes. Basalts, andesites, rhyolites, tuffs, breccias, and granites are the most common rock types of the plateau in our area. Except for granites, weathering of these rocks results in relatively fine grained minerals. However, bedrock outcrops are uncommon on the Nechako Plateau, and the widespread glacial till is of mixed origin and nature. Thus, surficial materials on the plateau do not necessarily reflect the nature of the underlying bedrock; indeed, local bedrock geology seems to have a rather weak influence on the mineralogic composition and texture of parent materials and soils in much of the SBS.

Northern and western sections of the SBS include the Hazelton and Skeena Mountains. The influence of bedrock geology on the nature of soil parent materials is more apparent in these more mountainous parts of the SBS. The bedrock geology of the Hazelton Mountains is primarily volcanic (andesitic to rhyolitic breccias and tuffs). Second in abundance are sedimentary rocks, of similar age, including sandstone, conglomerate, shale, greywacke, and siltstone. Granitic stocks are located within the Bulkley Ranges and Hazelton Peak, but granite forms a minor component of this physiographic region in general. In this area, weathering of volcanic bedrock results in fine grained deposits, while sedimentary and granitic rocks weather to more medium and coarser textured materials.

The northwesternmost section of the SBS falls within the Skeena Mountains. The bedrock of this region is largely folded sedimentary rocks including argillite, shale, and dark greywacke. Volcanic rocks are absent.

5.4 Climate (Hare and Thomas 1974; Schaefer 1978)

5.4.1 General

Weather systems generally move into British Columbia from the west. Moist air is drawn onto the coast and forced over consecutive mountain ranges. This process of 'orographic' lifting causes the cooling and subsequent condensation of moisture in the air, and results in large amounts of precipitation. After the air has passed over the Coast Mountains it is considerably drier and the lower layers are more easily heated or cooled by the underlying earth surface. This phenomenon repeats itself over subsequent mountain ranges and moisture is progressively wrung out of the air. By the time air masses travelling over west central B.C. reach our study area, the interior air is relatively dry and responsive to surface temperatures of the land. This results in a so-called continental climate.

Elevation, topography, and location play major roles in the determination of regional climate. Maximum temperatures decrease with increasing elevation. Minimum temperatures are highest on lower well-drained slopes; below this position, cold air drainage and pooling cause stagnation and cold temperatures while above this, air temperatures decrease rapidly with increasing elevation. However, temperature inversions are common in mountainous terrain especially in winter during outbreaks of cold polar or arctic air (cf. Daubenmire 1980). During temperature inversions cold air is trapped in the valleys by overlying warm air, and consequently air temperature increases as elevation increases.

Precipitation amount and intensity can be expected to vary directly with elevation. However, the rate of increase of precipitation with elevation varies with every location, with aspect, latitude, distance from the ocean, and the massiveness of the mountains. Mountains receive much more precipitation than the surrounding lowlands, and much of it comes in the form of snow. Total snowfall and precipitation within the study area generally decrease from northwest to southeast, for any given elevation.

'Potential evapotranspiration (PET)' is largely determined by the amount of solar radiation available, the humidity, and the surrounding air temperature. Therefore, the sunnier and warmer a site is, the greater the PET. If adequate water is available to plants, high PET values correlate with high ecosystem productivity. PET values are higher on south aspects and steeper south slopes; lower on north aspects and steeper north slopes. Northern and southern exposures also have differences in snow accumulation as well as insolation. However, aspect differences in microclimate and ecosystems are not marked in the SBS generally, due to the prevailing subdued topography.

Large lakes such as Francois and Babine have a moderating effect on extremes of temperature, resulting in longer frost-free periods and more 'growing degree days' in the vicinity of the lakes.

5.4.2 Sub-boreal climate

The climate of the SBS in the Prince Rupert Region is primarily continental; some lingering coastal influences still reach sub-boreal areas in the lower Bulkley Valley, and in the middle Skeena and upper Nass drainages. Continentality of the climate in the study area increases generally from west to east. Continental climates feature extremes of temperature and relatively low seasonal and annual precipitation. Maritime Polar air masses influence our SBS during the summer; during the winter, Continental Arctic, Continental Polar, and Maritime Polar air masses prevail. Characteristically the SBS has long, cold, and relatively dry but snowy winters and mild, moist, and short summers, with light to intense rainfalls of short duration.

More precisely, SBS climate may be characterized as a cold sub-boreal continental humid type, with severe, snowy winters and relatively warm, moist, and short summers. We use sub-boreal as a qualifier to distinguish it from a true boreal climate, as for example that of Dease Lake or Fort Nelson. In comparison with the boreal, sub-boreal climate is slightly less continental or polar/arctic, thus slightly warmer in January and cooler in July. Consequently, sub-boreal winters are shorter and the growing season slightly longer with also lower evapotranspiration. The better average growth of trees in the Sub-Boreal Spruce Zone than in the Boreal White and Black Spruce Zone, reflects the generally more favourable macroclimate of the SBS.

Refer to Table 3 for some representative details of the climate of the SBS.

TABLE 3. Climatic data[1] for the three Sub-Boreal subzones in the Prince Rupert Region.

SUBZONE	STATION	ELEVATION (m)	MEAN ANNUAL TEMP. (°C)	MEAN ANNUAL PPT. (mm)	MEAN ANNUAL SNOWFALL (mm)	MEAN SEASONAL TEMP. MAY-SEPT. (°C)	MEAN SEASONAL PPT. MAY-SEPT. (mm)	MEAN TEMP. COLDEST MO(°C)	NUMBER OF DAYS OF FROST	EXTREME MIN. TEMP. (°C)
SBSa	Alexis Creek-Tautri Creek	1132	0.3	417	1668.8	8.9	42.7	-13.6	277	-51.1
	Anahim Lake	1180	0.7	345.9	-	9.2	28.9	-12.8	260	-46.1
	Tatelkuz Lake	914	1.7	525.6	-	10.3	51.7	-12.0	-	-
SBSd	Burns Lake	761	2.1	512.6	1966.0	10.9	45.2	-13.6	228	-46.7
	Ootsa Lake	926	3.1	438.2	1765.3	11.3	36.7	-10.3	198	-41.1
	Smithers Airport	563	3.5	512.3	1973.6	12.1	41.7	-10.6	200	-43.9
	Smithers CDA	554	3.1	492.3	1668.8	11.6	41.6	-10.5	221	-44.4
	Telkwa	683	3.1	467.1	1808.5	11.7	42.6	-10.2	215	-41.1
	Wistaria	939	4.0	442.7	1993.9	10.7	38.3	-10.9	217	-43.9
	Nadina River	787	-	463.6	1770.4	-	39.2	-	-	-
SBSe	Babine Lake (Nilkitkwa)	774	1.1	600.7	2705.1	10.2	47.4	-14.9	238	-43.9
	Germansen Landing	803	0.4	525.0	2570.5	10.6	41.8	-17.5	238	-47.2

TABLE 3 (cont'd.). Climatic data[1] for the three Sub-Boreal subzones in the Prince Rupert Region.

SUBZONE	STATION	MEAN SEASONAL TEMP. JUNE-AUG (°C)	MEAN TEMP. WARMEST MO.(°C)	EXTREME MAXIMUM TEMP. (°C)	DRIEST MONTH	TOTAL PPT. DRIEST MO.(mm)	WETTEST MONTH	TOTAL PPT. WETTEST MO.(mm)	NO. MO. MEAN MO. TEMP. 0°C	NO. MO. MEAN MO. TEMP. 10°C	FROST FREE PERIOD (DAYS)
SBSa	Alexis Creek-Tautri Creek	10.5	11.7	30.6	April	19.6	Aug.	54.9	5	2	12
	Anahim Lake	10.8	12.9	31.1	May	13.9	July	47.2	5	2	-
	Tatelkuz Lake	11.9	12.8	-	March	21.9	July	60.1	5	3	30
SBSd	Burns Lake	12.5	13.1	32.2	April	21.8	July	58.9	5	3	52
	Ootsa Lake	12.9	13.7	33.3	March	25.4	July	39.6	5	4	92
	Smithers Airport	13.7	14.6	33.8	April	21.8	Oct.	59.9	5	4	82
	Smithers CDA	13.2	14.1	37.2	April	20.6	Dec.	55.6	5	3	52
	Telkwa	13.3	14.2	37.8	April	19.6	July	52.3	5	3	82
	Wistaria	12.4	13.3	36.1	April	19.3	Dec.	50.0	5	3	67
	Nadina River	-	-	-	April	17.5	Dec.	57.7	5	-	-
SBSe	Babine Lake (Nilkitkwa)	12.0	12.9	32.8	April	29.5	Dec.	67.3	5	3	54
	Germansen Landing	12.5	13.7	32.2	March	29.2	Dec.	60.5	5	3	55

[1] Data from Environment Canada (1970).

5.5 Vegetation (Runka 1972; Cotic et al. 1974)

5.5.1 Upland forest

Upland coniferous forests dominate the sub-boreal landscape. Picea glauca x engelmannii (hybrid white spruce) and Abies lasiocarpa (subalpine fir) are the major climatic climax species in the study area and often occur in mixture; pure stands of either species are uncommon. Picea mariana (black spruce) also occasionally occurs in climax forest. Subalpine fir is the most shade-tolerant species in the SBS. It appears that in the moister parts of the zone, especially at higher elevations, A. lasiocarpa increases in abundance with increasing stand age, and would eventually dominate the climax forest with hybrid white spruce as a co-dominant or subordinate species. However, the forest fires that are so common throughout the zone arrest such succession, so that subalpine fir is often found only in the sub-canopy or as regeneration in the shrub layer of seral stands.

Note that the upland "white" spruce of the zone appears to be predominantly hybrid (Wright 1955; Garman 1957; Daubenmire 1968, 1974; Roche 1969; Ogilvie 1972; Fowler and Roche 1975; Douglas 1978), although in any given population it is not unusual to find individual trees that in external appearance approach either pure Picea glauca or P. engelmannii.

Pinus contorta (lodgepole pine) and Populus tremuloides (trembling aspen) pioneer the extensive areas affected by recent fires, and form frequent and widespread seral stands. However, the more shade-tolerant spruce and subalpine fir usually also occur in seral stands, if only as a minor component or scattered regeneration. There is a general tendency for lodgepole pine to dominate seral forests on coarser textured, usually more acidic soils, and trembling aspen to dominate on finer textured soils (which tend to have a higher base status). Aspen also appears to prevail over areas that have been repeatedly burned or formerly cultivated. *Betula papyrifera* (paper birch) may also develop as a seral species usually on moister and nutritionally richer sites.

Alluvial or gallery forests of *Populus balsamifera* ssp. *trichocarpa* (black cottonwood), often with a minor component of hybrid white spruce, occur on active floodplains along the major streams of the study area. *Pseudotsuga menziesii* var. *glauca* (Douglas-fir) just barely reaches the easternmost portion of the study area. Here, along the northern limit of its range, the species occurs sporadically, usually in drier warmer richer habitats near large lakes such as along the eastern ends of Babine and Francois Lakes.

5.5.2 Wetlands

Wetlands are common and dot the landscape in poorly drained postglacial depressions or river ox-bows. Wetland types include *Carex* 'marshes' and 'fens', shrub fens of *Betula glandulosa* and *Salix* spp., treed fens and 'swamps' with both *Picea mariana* and *P. glauca* x *engelmannii*, and *P. mariana* - *Sphagnum* 'bogs'. Acid, nutrient-poor black spruce - sphagnum bogs are less common than the richer wetland types (marsh, fen, swamp). Wetlands are abundant in the SBS but never so extensive as they are in the Boreal White and Black Spruce Zone (BWBS).

5.5.3 Aquatic vegetation

Aquatic and semiterrestrial vegetation develop along the margins of lakes and streams. Species of *Carex* and *Potamogeton*, *Equisetum fluviatile*, and *Nuphar lutea* subsp. *polysepala* are characteristic.

5.5.4 Grassland and scrub

Natural grassland and 'scrub-steppe' are uncommon within the Sub-Boreal Zone, and occur on favourable, warm dry sites scattered throughout the major valleys. Fire and topography are largely responsible for the establishment and maintenance of such vegetation. *Agropyron trachycaulum*, *Stipa richardsonii*, and species of *Poa* and *Bromus* are characteristic grasses. Shrubs such as *Amelanchier alnifolia*, *Prunus virginiana*, and *Symphoricarpos albus* dominate the scrub. *Juniperus scopulorum* is sporadic in the SBS and is restricted to such topoedaphic sites, where it occurs as a tall shrub/small tree in juniper 'savanna' or 'savanna-scrub'.

5.6 Soils (Farstad and Laird 1954; Runka 1972; Cotic 1974; Valentine et al. 1978; Klinka et al. 1981).

Many factors interact in the formation of soils. Parent materials, climate, topography, biota, and time react together at different intensities to form a particular soil.

Many soil types in a variety of ecosystems occur in the Sub-Boreal Spruce Zone. However, three soil orders dominate the zone: Luvisols, Brunisols, and Podzols. It is instructive to outline the distribution of soil great groups from these and other minor orders, within the framework of the surficial geology of the study area.

5.6.1 Soils developed on glacial till

Brunisolic and Orthic Gray Luvisols are the most common soils found on glacial till in the SBS. These soils form under the humid to subhumid soil moisture regimes that prevail over much of the SBS, especially on the Nechako Plateau. Brunisols and Podzolic Gray Luvisols may also form under slightly higher moisture conditions, especially in the more mountainous western and northern portions of the zone, and at higher elevations of the plateau. Coarser textured Brunisols and Humo-Ferric Podzols also tend to develop in these moister areas, on till from which many of the clay particles have been washed out.

Orthic and Eluviated Dystric Brunisols also frequently occur in association with Luvisols even under subhumid soil moisture regimes, particularly on till which has been water-worked. Brunisols in general are believed to be relatively weakly developed soils, only moderately altered from the original parent material (Valentine and Lavkulich 1978). Relatively low precipitation and long cold winters prevail in the SBS, conditions under which weathering and profile development are limited. But Luvisols occur over much of the morainal deposits in the zone, so where Brunisols have developed in an otherwise luvisolic landscape, presumably the till is not calcareous or fine textured enough for Gray Luvisols to develop (Valentine and Dawson 1978).

Imperfectly drained depressions or moisture-receiving sites within the morainal landscape typically support Gleysols or gleyed subgroups of Luvisols, Brunisols, and Podzols.

5.6.2 Soils developed on glaciofluvial deposits

Brunisols and Podzols predominate on glaciofluvial landforms. Orthic Humo-Ferric Podzols often occur on coarse textured landforms such as outwash plains, terraces, and kames, particularly in areas of higher precipitation (i.e., SBSe). Orthic Dystric Brunisols have formed on similar landforms under lower moisture regimes (i.e., SBSd), especially in major valley bottoms and on leeward, lower mountain slopes.

5.6.3 Soils developed on fluvial deposits

On fluvial sites within the SBS, Orthic Dystric Brunisols, Orthic Regosols, and Orthic Humo-Ferric Podzols are often found. Gleyed subgroups occur regularly within the Regosolic and Brunisolic orders, denoting fluctuating water tables commonly associated with floodplains. Regosols are common on recent (active) flood plains, while Brunisols and Podzols are often located on older fans and terraces. Textures of fluvial deposits vary from coarse gravels to silts.

5.6.4 Soils developed on colluvial deposits

Where steep slopes and colluvial deposits predominate in the SBS, coarse textured to fragmental Orthic Dystric Brunisols and Orthic Humo-Ferric Podzols occur. In these areas, effective precipitation increases as elevation increases, resulting in a gradation from Brunisolic to Podzolic profile development.

5.6.5 Organic soils

Weakly decomposed organic soils including Fibrisols and Mesisols can be found in poorly drained, depressional wetlands of the SBS. Folisols (thin organic soils over bedrock) may be found on steep slopes of the Skeena and Hazelton Mountains, or localized on some bedrock knobs in the SBS.

5.6.6 Organic matter accumulation in mineral soils

'Ah' development occurs in some soils, particularly in areas where seral ecosystems have been maintained. In dry grassland or scrub ecosystems, which are often burned and located on warm south-facing hill slopes, decomposition of grass roots leads to the formation of Ah horizons. In moister ecosystems such as horsetail, devil's club, and floodplain types, biological activity is at a maximum in the SBS. The Ah horizons which develop under these conditions typify such soils as Melanic Brunisols, Dark Grey Luvisols, Humic Regosols, and Humic Gleysols.

5.6.7 Humus

'Humus' formation in the SBS depends on slope position, temperature, litter type, and moisture at any given location. 'Mor' humus forms prevail at middle to upper elevations in the mountainous areas and over the northern Nechako Plateau where colder temperatures and higher moisture conditions exist. Decomposition under these conditions is slow and is carried out primarily by fungi. 'Moder' humus forms are common in warmer, moist areas (SBSd) where climate and the mixed deciduous and coniferous nature of the litter favour insect decomposition, but mor humus is common as well in the SBSd.

Ah horizons and a deciduous component to the forest are often associated with moder humus forms. 'Mull' humus forms are found primarily under the grasslands of the southern SBS. Biological decomposition is rapid, with organic accumulation a dominant feature of the surface soil horizons.

6.0 MODIFYING FACTORS

6.1 Settlement (Large 1957; Shervill 1981)

This discussion deals only with the initial settlement by white men of the study area, the Sub-Boreal Spruce Zone of the Prince Rupert Forest Region. It does not take into account the effects of the aboriginal population (in this case the Carrier Indians) on the area, although the native Indians undoubtedly affected their forest surroundings, probably mainly by setting fires. It is a convention among North American ecologists to consider "pre-contact", aboriginal man a harmonious component of natural, pristine ecosystems, and to date all departures from and modifications to the primeval state from the advent of agroindustrial (usually white, European) man.

The Hudson's Bay Company established the first settlement in the area, Fort Kilmaurs (later Old Fort Babine) on Babine Lake. The next major incursion into the area came with the attempt to construct a telegraph line connecting North America and Eurasia via Russia. The Western Union Telegraph Company sent surveyors and construction crews into the Bulkley Valley in 1866. They were to explore and construct a trail, the so-called Collins Overland Telegraph Trail, as the link between Fraser Lake and Hazelton in the line which was to run from San Francisco north to the Bering Sea. T. Elwyn, a member of this exploration team, recorded the Bulkley Valley as "... having plenty of grass and very little timber" and "with the exception of a few heavy patches of scattered timber ... either entirely open or covered with small timber brush ..." (as quoted in Shervill 1981).

The telegraph trail through the Bulkley Valley was used over the next 25 years by occasional travellers and pack trains headed north. Most of the traffic was associated with the Omineca (1869-1873), Cassiar (1872-1880), and Klondike (1898) gold rushes. Some of the prospectors probably returned later to settle in the area, but the earliest formal settlement occurred around 1902. In that year the Grand Trunk railway announced its intentions to build a transcontinental railroad from Moncton, New Brunswick to Kaien Island (now the site of Prince Rupert) on the Pacific coast. The railroad was to run along the Nechako and Bulkley rivers in central B.C. A minor land rush ensued along the proposed line, so most of the farmland in the Bulkley Valley had already been bought or pre-empted by the time the railroad was built, between 1907 and 1914. The building of the railroad itself occasioned much clearing, tie-cutting, and setting of fires.

The pattern of settlement in the study area was thus well-established by 1920. Settlements and agricultural land fall largely within the SBSd. The primary impact on forest ecosystems from the post 1850 exploration and settlement has been forest clearing. Much of the settled area of the SBS thus presents a patchwork or mosaic of seral vegetation in various stages of succession after clearing. The open, often deciduous nature of the vegetation was recorded as early as 1866. Even the "pre-historic" Indians and the earliest travellers and settlers caused disturbances, and their effects have persisted in some areas to this day. Therefore it is sometimes difficult to see why the SBSd should be termed part of a "spruce" rather than an "aspen" or "pine" zone. However, careful investigation reveals that, in the SBSd, aspen and pine are definitely seral species and spruce a climax, shade-tolerant species. The existing vegetation can be best understood as a complex response to conditions of climate, soil, and topography, mediated by disturbance (usually fire) and time. In this respect, some early surveyors in the Bulkley Valley made instructive observations (Department of Lands, Survey Branch, Province of British Columbia 1929), among them those of Poudrier (1892):

"About one-fourth of the whole valley ... consists of prairie and open land. These openings have been formed only of late years. The travellers along the river and the trail occasioned many fires, and in these cases the growth of trees and shrubs was replaced ... by prairie".

6.2 Roads

Until fairly recently, the road system in the study area was confined largely to the major valleys and settled areas, especially along the main transportation corridor of the Bulkley - Endako valley system. However, particularly with increased levels of logging and increased hauling distances to sawmills, a network of roads has now been established over much of the SBS, excluding the more remote and rugged northern and western portions of the zone.

Regardless of the benefits that roads bring to the regional economy, such as in transportation, communication, and recreation, they have some direct and indirect negative effects on the environment. All roads remove land from production, whether of trees or forage. If not properly serviced with culverts, roads can cause roadside flooding and drowning of trees, especially in low flat areas. Roads can expose large fronts of trees that are not windfirm, and may subsequently blow down. Roads may also initiate or exacerbate slope failures in unstable terrain. More roads result in better access to the hinterland and more recreational use, which can reach harmful levels in some areas.

6.3 Hydroelectric Development

Hydroelectric impoundments in British Columbia usually represent large, essentially irreversible losses of standing timber and productive forest land. Large losses have already occurred due to the Alcan project, when in 1951-52 the Aluminum Company of Canada dammed the Nechako River, raised the levels of Whitesail, Tahtsa, Ootsa, Natalkuz, Euchu, Chelaslie, and Tetachuck lakes, and reversed the drainage direction through a tunnel to Kemano on the coast. Most of the resultant flooding took place in the Sub-Boreal Spruce Zone. Additional losses will result if the so-called Kemano Completion project proceeds as Alcan plans. B.C. Hydro also has designs on the Nass and Skeena rivers which could affect SBS forest land.

Hydroelectric power lines also have removed substantial areas from timber production, and these losses will increase as B.C. Hydro amplifies its power grid.

6.4 Grazing

The total cattle population in the Prince Rupert Region as of summer, 1981 was about 24,000 head (A. Moi, personal communication). Most of the grazing occurs in the Sub-Boreal Spruce Zone, especially the SBSd. Much of the grazed area is private land, but grazing permits for 8,745 head on Crown land were authorized in 1980 (A. Moi, personal communication). Small numbers of sheep (perhaps 500), goats, and horses are also grazed in the area, mostly on private land.

Grazing land in the SBS is usually established and maintained at the expense of forests. Cattle ranchers clear land of trees, either by mechanical means or fire, and promote cover of grasses and forbs. However, sizeable areas of forested rangeland are also utilized especially in the SBSd.

The direct effects of grazing in the forest are not fully understood. Heavy concentrations of cattle result in root damage and trampling of vegetation, and perhaps compaction of soil. Livestock may also damage coniferous tree seedlings in plantations, although such damage is severe only if cattle concentrations are high. In general the selective effect of livestock foraging modifies vegetation by reducing the vigour and abundance of some plant species while promoting the increase of less-preferred species.

6.5 Logging

Prior to 1960, logging in the study area occurred mainly in the more accessible areas along or close to main roads, usually in the major valleys of the SBSd. The logs were destined for local, domestic use, production of railroad ties, and a small export lumber market. Horses and later mechanical skidders were used in the forest. As the more accessible blocks of good pine and spruce forest were used up, operators began to use small portable mills which could be moved to smaller, scattered stands of desirable timber.

The scale of logging changed dramatically around 1965 or so. Timber rights and holdings were consolidated by fewer operators, who invested in larger, more centralized sawmills which drew wood from large supply areas. Today there are major mills in Houston, Burns Lake, and Smithers, with only a few additional small mills scattered through the area but usually close to the railroad.

Early logging systems selected individual trees, or small groups or small stands of prime trees, resulting in scattered or patchy disturbance of the forest cover. Regeneration was left largely to nature. However, present-day logging systems, which involve large scale clearcutting, result in a much greater magnitude of disturbance. Currently in the SBS of the Prince Rupert Region, 10,000 or more ha per year are cut over (information supplied by Silviculture Section, Prince Rupert Forest Region, B.C. Ministry of Forests 1981). Some of the logged-over land is planted, some is left to natural regeneration. However, regardless of the mode or rate of recovery, the forest ecosystems have been radically disturbed. Logging is currently by far the major modifying or disturbing factor in the SBS. Modern forestry is practiced on the assumptions that the disturbance due to logging, though radical, is not long-term; does not necessarily reduce the wood-growing potential of forest land; and can be manipulated to produce successive generations of crop trees. It is not the purpose of this publication to discuss the validity of these assumptions, or to evaluate short-term economic considerations against the silvicultural and ecological aspects of forest utilization. However, as do Kabzems et al. (1976), we would like to promote a wider understanding and acceptance of the ecosystem concept in forest resource management.

6.6 Fire

Forest fires have, until relatively recently, been the major modifying force in the Sub-Boreal Spruce Zone. Prior to the active fire suppression programs begun in the area in the 1920's, it seems likely that any given forest stand in the SBS would have burned at least once every 300 years, and most stands probably once every 100 years (cf. Rowe and Scotter 1973; Van Wagner 1978; Stokes and Dieterich 1980). Nearly every plot that we sampled in the study area had some evidence of past fire, usually as a charcoal layer in the soil profile. Past forest fires have been a dominant factor in determining the natural regeneration and distribution of tree species in the Sub-Boreal Zone, and in determining the pattern of ecosystem development over the sub-boreal landscape.

Today both natural and man-caused forest fires still occur, but have been greatly reduced in extent by modern fire suppression activities. However, much of the impact of previously widespread wildfire has been taken up by industrial forestry, in which extensive clearcutting, often followed by broadcast burning, at least partially mimics the effects of natural fire.

Both natural and prescribed fire have harmful and beneficial effects on forest ecosystems, depending on circumstances (Dodge 1972; Koslowski and Ahlgren 1974; Wright 1974; Wells et al. 1979; Macadam 1981). These effects will not be discussed here (see Sec. 9.4.2 and 9.4.3). However, we must emphasize that fire has been and will continue to be an integral force in the SBS and that forest managers, including those involved in forest protection, silviculture, range, wildlife, and recreation, must be aware of the role of fire in northern forest ecosystems.

7.0 SUB-BOREAL SPRUCE ZONE

The Sub-Boreal Spruce Biogeoclimatic Zone falls between roughly 52° and 57° N. lat. and 122° and 128° W. Long., in the central interior of British Columbia (Fig. 4). Rowe (1972) has classified this area as part of his Subalpine and Montane forest regions. However, we follow Krajina's (1965) concept of the SBS as the southernmost (in B.C.) zone of the Canadian Boreal Forest Region. We view the forests of the SBS as broadly transitional between true montane forests of Douglas-fir to the south, boreal forest to the north, and subalpine forest at higher elevations.

7.1 Subzones

Previous studies of the SBS have been done in the eastern (Illingworth and Arlidge 1960; Revel 1972; Wali and Krajina 1973; Harcombe 1978), southern (Illingworth and Arlidge 1960; Annas and Coupé 1979), west central (Cotic et al. 1974), and northwestern (Runka 1972) sections of the zone. The SBS is still incompletely known in B.C., although studies are continuing and several subzones have been identified to date. Our studies have occurred in the northwestern section of the SBS, where we have distinguished three subzones (Fig. 5):

1. SBSa, the "pine - spruce" or "Chilcotin pine" subzone (Annas and Coupe 1979)
2. SBSd, the "spruce" subzone
3. SBSe, the "subalpine fir" subzone

The majority of the SBSa occurs to the south of the study area, in the Cariboo Forest Region. The SBSd occurs largely in the Prince Rupert Forest Region. The SBSe occurs across north central B.C. and extends to the east of the study area, in the Prince George Forest Region. It appears that this eastern portion of the SBSe, which occupies the northern part of the Fraser Basin and adjacent parts of the Omineca Mountains and Rocky Mountain Trench, represents a different biogeoclimatic variant characterized by the occurrence of Douglas-fir, among other things. Hence, we have designated the variant in our study area the SBSe1, while to the east, off the Nechako Plateau and in the Prince George Forest Region, is the SBSe2.

7.1.1 SBSa (Pine - spruce subzone)

The SBSa or pine - spruce subzone occurs in only a small portion of the study area, roughly south of Ootsa-Natalkuz lakes and east of Tweedsmuir Park, mostly in the Entiako River drainage (Fig. 5). There is not much of this subzone in the Rupert Region; logging has only just begun to penetrate it; and we have done very limited reconnaissance and sampling in the SBSa. Therefore we will limit ourselves to a general discussion of the pine - spruce subzone, describe some of its salient ecological features, and add a few silvicultural notes.

7.1.1.1 Ecological features (Annas and Coupé 1979; Annas et al. 1981)

The SBSa ranges from 850m to 1200(-1400)m in the Prince Rupert Region. The pine - spruce subzone has the driest, coldest, most severe climate of all the SBS subzones (see

Table 4. Ecological Attributes of the Three Sub-Boreal Subzones in the Prince Rupert Region.

SUBZONE	ELEVATION Range (m)		CLIMATE				VEGETATION		SOIL		
		Station	Station Elev. (m)	Mean Annual Temp. (°C)	Mean Annual Precip. (mm)	Frost Free Period (days)	Zonal Plant Association	Other Features	Zonal Soils & Humus Form	Mean Annual Soil Temp. of a Zonal Ecosystem[b] (°C)	Other Features
SBSa	850-1400	Alexis Creek -Tautri Cr.	1311	0.3	417	12	(1) Pl - (Sw) Juniperus communis - Arctostaphylos uva-ursi - lichen	-Pl and Sw regeneration -lack of Bl -poorly developed shrub & herb layers -moderately developed moss layer, with abundant lichens -Calamagrostis rubescens present -scarcity of Hylocomium splendens & Ptilium crista-castrensis -Carex marshes and fens very common; black spruce bogs absent	Brunisolic Gray Luvisols		
		Tatelkuz Lake[a]	914	1.7	526	30	(2) Pl - (Sw) - Rosa acicularis - Arctostaphylos uva-ursi - Pleurozium schreberi - lichen		Orthihemimor		
SBSd	550-1100	Burns Lake	761	2.1	513	52	/01 Pl-Sxw - (At) - Rosa acicularis - Lathyrus nevadensis - Pleurozium schreberi	-Sxw regeneration -lack or scarcity of Bl -well developed herb and shrub layers -moss layer moderately to well developed -Juniperus scopulorum present -relative abundance of Rhytidiadelphus triquetrus -natural grassland or scrub present	Brunisolic Gray Luvisols, Dystric Brunisols Hemimors (Mormoders)	3.8	Zonal soils on morainal blankets and occasionally on fluvialglacial landforms; Ae horizons not pronounced; relatively well developed structure in upper solum. Soils freeze relatively early, thaw early.
		Ootsa Lake -Skins Lake Spillway	926	3.1	438	92					
		Wistaria	939	4.0	443	67					
SBSe	750-1300	Babine Lake (Nilkitkwa)	774	1.1	601	54	/01.1 Sxw-Bl-Vaccinium membranaceum - Cornus canadensis - Pleurozium schreberi - Ptilium crista-castrensis /01.2 Sxw-Bl - Cornus canadensis - Rubus pedatus - Pleurozium schreberi - Ptilium crista-castrensis	-Bl and Sxw regeneration -abundance and dominance of Bl -moderate to poor shrub & herb devlopment -moss layer very well developed -presence of Vaccinium membranaceum, Oplopanax horridus, Gymnocarpium dryopteris, Dryopteris assimilis, Athyrium filix-femina, Streptopus roseus, Tiarella trifoliata	Gray Luvisols, Dystric Brunisols, Humo-Ferric Podzols Hemimors	2.8	Zonal Soils on morainal blankets, less commonly on fluvial fans & fluvial & fluvialglacial terraces; Ae horizons more pronounced; relatively weak or massive structure. Soils freeze late, thaw late
		Germansen Landing	803	0.4	525	55					
		Topley Landing[a]	750	2.1	550	--					

[a] Short term data only.

[b] Unpublished data of Trowbridge (1982 - E.P. 920).

Tables 3 and 4), and the prevailing low forest productivity reflects this severity of climate. Lodgepole pine and white spruce are the dominant trees. The spruce appears to be either pure white or, if hybrid, predominantly white spruce. Black spruce may be found both in bogs and on upland sites in the northeastern portion of this subzone (i.e., the Blackwater drainage), but is absent from the SBSa portion of our study area. Douglas-fir is also lacking and subalpine fir is either absent or very minor. Trembling aspen is the major deciduous tree, but there is much less of it in the SBSa than in either the SBSd or e.

Extensive even-aged stands of lodgepole pine dominate the rolling plateau landscape of the SBSa, interrupted only by the depressional wetlands or "wet meadows" so typical of the Chilcotin. In our portion of the SBSa, which is moister and milder than the Anahim Lake country, white spruce commonly occurs in the understory of these pine stands, or as regeneration. Spruce in the overstory is a much less common occurrence but mature pine - spruce or spruce - pine stands can be found in moister depressions, frequently ringing wetlands.

White spruce is the theoretical climatic climax species in the SBSa. However, given the extensive fire history of the area and the extreme slowness of succession, pine or pine - spruce stands can be considered as climatic fire climaxes that without further disturbance would eventually climax in spruce.

Zonal or mesic ecosystems of the SBSa characteristically have sparse shrub and herb layers and, in our study area (which represents a moister, milder variant of the subzone) a moderately developed moss layer that frequently has a strong lichen component. Typical species of the shrub layer include *Juniperus communis*, *Shepherdia canadensis*, *Rosa acicularis*, *Spiraea betulifolia*, regeneration of pine and spruce, and the occasional willow (*Salix glauca*, *S. scouleriana*, *S. bebbiana*) or alder (*Alnus viridis*).

The herb layer typically includes *Linnaea borealis*, *Vaccinium caespitosum*, *Arctostaphylos uva-ursi*, *Cornus canadensis*, *Geocaulon lividum*, *Epilobium angustifolium*, *Achillea millefolium*, *Fragaria virginiana*, *Oryzopsis pungens* or *O. asperifolia*, and *Calamagrostis canadensis* or *C. rubescens*. Generally no one species dominates the herb layer.

Pleurozium schreberi and lichens dominate the moss stratum. Typical lichens are *Cladonia gracilis*, *Cladina rangiferina*, *C. mitis*, *C. arbuscula*, *Peltigera aphthosa* and *P. malacea*, and *Stereocaulon tomentosum*. *Dicranum fuscescens*, *D. polysetum*, and *Ptilidium ciliare* are other frequent bryophytes. The relative abundance of terrestrial lichens on zonal or climatic climax sites reflects the drier mesoclimate of the SBSa.

Zonal soils are Brunisolic Gray Luvisols, loamy (coarse to fine) in texture, well-drained, and moderately pervious. Orthic and Gleyed Gray Luvisols as well as Dystric Brunisols may also occur on mesic sites. The zonal luvisolic soils typically have developed on morainal blankets that often are compacted. Zonal humus form appears to be an Orthihemimor, often fairly thin.

Zonal soils are characterized by a thin, often discontinuous litter layer (L) of conifer needles and other organic debris, overlying dark brown decomposed organic materials (F and sometimes H horizons) that usually are less than 10 cm thick. The solum consists of a light brownish gray sandy loam or sandy clay loam horizon (Bm or AB) over a grayish brown sandy to clay loam horizon (Bt). A light gray leached horizon (Ae) may occur below the Bm. The structure of the mineral soil is usually subangular blocky, with pseudo-platy features often showing up in the grayish brown sandy to clay loam horizon (BC) under the Bt. The compacted pseudo-platy parent material (C) is usually light brownish gray.

Species common in wetter, subhygric forest ecosystems include white spruce, trembling aspen, black cottonwood, *Equisetum arvense*, *Aster conspicuus*, *Smilacina stellata*, *Agropyron trachycaulum*, *Bromus carinatus*, *Carex disperma*, *Salix glauca*, *S. barclayi*, and *S. drummondiana*.

The wetlands of the SBSa are among its most characteristic features. They are mostly marshes and fens (richer, 'minerotrophic' wetland types) and include at least five common associations, often developing in concentric bands with drier types towards the periphery of wet depressions. Common marsh and fen species include Carex rostrata, C. aquatilis, Deschampsia caespitosa, Juncus arcticus, Salix pedicellaris, S. maccalliana, S. glauca, S. brachycarpa, Betula glandulosa, Aulacomnium palustre, Tomenthypnum nitens, and Drepanocladus spp. Sphagnum moss is not a dominant feature of these fens. Wetland soils generally are organic, but gleyed mineral soils do occur in the drier 'shrub - carrs' and herbaceous meadows (Runka and Lewis 1981).

Within our study area the SBSa appears most closely related to the SBSd. The SBSa has a colder drier climate than the SBSd, and has a significantly shorter frost free period. The two subzones can be distinguished in the field on the basis of climax tree species, understory development, and the structure and composition of the moss stratum. Table 4 organizes some climatic, vegetative, and edaphic information for comparison among the SBSa, d, and e.

7.1.1.2 Silvicultural considerations

The SBSa has low forest productivity compared to the SBSd and e. Lodgepole pine and white spruce are the main commercial species of the SBSa. Six main factors influence the silviculture of the extensive pine forests of this subzone in the Prince Rupert Region: (a) the distance from the stands to sawmilling centres; (b) the even-aged nature of the stands which have almost always developed after wildfires; (c) the pioneering ability of the tree species; (d) the abundance of mistletoe within commercial stands; (e) the degree of insect attack [mainly by mountain pine beetle (*Dendroctonus ponderosae*) and spruce beetle (*D. rufipennis*)] within commercial stands; (f) the serotiny of lodgepole pine cones.

The remoteness of the SBSa makes both logging and post-logging treatment expensive. The even-aged stands are ideal for logging but unfortunately also for mistletoe infestation and mountain pine beetle or spruce beetle epidemics. Large clearcuts may be necessary either to salvage beetle-killed stands or to reduce the area of regeneration susceptible to mistletoe infestation from perimeter stands. However, the absence of cone serotiny in some populations of lodgepole pine may necessitate planting or leaving seed trees to ensure restocking after logging. If natural regeneration can be relied on, it is imperative that sufficient cones be scattered over the logged area to provide adequate seed density to establish the next crop.

Thinning will probably not be practiced on the present overstocked pine stands because of their remoteness and relatively low productivity.

7.1.2 SBSd (Spruce subzone)

7.1.2.1 Regional setting

The SBSd is the settled sub-boreal subzone of the Prince Rupert Region. The spruce subzone covers the lower elevations of the major Bulkley-Endako valley system and much of the Lakes District south of Burns Lake (Fig. 5). The major population centres of the study area, such as Burns Lake, Houston, Telkwa, and Smithers, all occur in this subzone, as do most of the smaller ranching communities. The boundaries of the SBSd also roughly coincide with the limits of suitable grazing land for domestic livestock.

The spruce subzone occupies the major valley bottoms and lower and mid-slopes of the central Nechako Plateau. The SBSd ranges in elevation from 700 to 1100 m in the south (Lakes country), and from 550 to 750 m in the north (Bulkley Valley).

7.1.2.2 Climate

The climate of the SBSd is intermediate between that of the SBSa and e (Tables 3 and 4). The SBSd is moister and warmer than the SBSa, drier and warmer (especially in summer) than the SBSe. Winters are still severe, but the growing season of the SBSd is significantly longer and warmer than those of both other subzones. Also, the SBSd has considerably less snowfall and a shorter duration of snowpack than the SBSe. Human settlements and land use patterns in the Bulkley-Nechako district reflect the comparatively favourable climate of the spruce subzone.

7.1.2.3 Vegetation

Major tree species of the spruce subzone include hybrid white spruce, lodgepole pine, trembling aspen, and black cottonwood. Black spruce, subalpine fir, and paper birch are minor species, and Douglas-fir is rare.

The mesic or zonal plant association of the SBSd can be characterized as Pinus contorta - Picea glauca x engelmannii - (Populus tremuloides) - Rosa acicularis - Lathyrus nevadensis - Pleurozium schreberi. The most common cover types found in this, the most abundant association of the SBSd, are pine - spruce or pine - spruce - aspen mixtures. In young seral stands spruce may occur only in the understory or as regeneration. Pure stands of either pine or spruce are rare on mesic sites. Aspen forms pure mesic stands more commonly, especially on south slopes with fine-textured soils. However, if undisturbed for long enough, even these aspen stands would eventually break up and spruce would take over.

The vegetation of mesic ecosystems typically has moderately well-developed, vigorous, shrub and herb layers. The shrub layer is usually dominated by a relatively diverse group of medium-tall shrubs with lots of medium-sized leaves (e.g., *Rosa acicularis*, *Viburnum edule*, *Rubus parviflorus*). Similarly, the herb layer usually consists of a diversity of leafy forbs (e.g., *Lathyrus nevadensis*, *Aster conspicuus*). Grasses such as *Calamagrostis canadensis* and *Elymus glaucus* are also common in mesic SBSd ecosystems, much more so than in the SBSe.

The moss layer of mesic SBSd vegetation is moderately to well developed, but usually not nearly as well developed as in the SBSe. *Pleurozium schreberi* dominates overall. *Rhytidiadelphus triquetrus* is common though not abundant in the spruce subzone, but is much more abundant in this subzone than in the SBSe.

In older stands or at higher elevations within the subzone, both the shrub and herb layers tend to thin out, while the moss layer becomes thicker and more continuous. Species such as *Shepherdia canadensis* and *Lathyrus nevadensis* may become scarce or disappear, but generally stands do not get old enough to attain such advanced successional status.

Additional significant floristic features of the SBSd include the lack or scarcity of subalpine fir and *Vaccinium membranaceum* in zonal ecosystems, and of *Oplopanax horridus*, Gymnocarpium dryopteris, Athyrium filix-femina, Dryopteris assimilis, Streptopus roseus, and Tiarella trifoliata in moister richer ecosystems. All of these species are common in the SBSe.

Black spruce is only rarely found in upland forest in the SBSd. Douglas-fir is rare in the subzone, and in our study area usually occurs in dry, warm habitats on residual soils over "richer" bedrock. In the spruce subzone, subalpine fir and paper birch usually occur in moist, rich ecosystems, especially on northern or eastern slopes.

Other distinctive features of the vegetation of the spruce subzone include the presence of Juniperus scopulorum (Rocky Mountain juniper) on dry rich sites, usually where a richer bedrock is close to the surface. Natural grassland and scrub-grassland also occur in the SBSd on topoedaphically favourable, dry warm sites, but they are relatively infrequent and local. In some areas part of what is now cultivated or pasture land may originally have been native grassland, but we can only guess without detailed historical records.

Wetlands are common in the SBSd and include marshes, fens, swamps, and bogs. Minerotrophic wetlands are the dominant types, but acid, nutrient-poor black spruce - Ledum groenlandicum - Sphagnum bogs are still relatively frequent.

7.1.2.4 Soils

Zonal ecosystems of the SBSd generally develop on morainal blankets, less frequently on ice-contact fluvialglacial deposits. The finer textured parent materials have given rise to luvisolic (Bt) development, while the coarser textured parent materials show brunisolic (Bm) development (podzolization has not been identified as a soil-forming process in any of the ecosystems of the SBSd). The organic horizons range in total thickness from 5 to 15 cm, and are dominated by a fungal or zoogenous F horizon. The humus forms are commonly Hemimors or Mormoders.

Drier ecosystems with poorer nutrient regimes are often rapidly drained and may have deep gravelly to cobbly fluvial parent materials, or veneers of colluvial, morainal, or residual soils over bedrock. These soils are usually classified as Regosols or Brunisols, and generally have thin, crusty organic horizons that have been classified as Xeromors.

The drier, richer ecosystems show strong Ah development. The soils have been classified as Melanic and Sombric Brunisols and Dark Gray Luvisols while the humus forms are Rhizomulls. The parent materials are colluvial, morainal, or lacustrine.

The moister, richer ecosystems are well to poorly drained and their soils have developed from fluvial, colluvial, morainal, or lacustrine parent materials. Pedogenesis varies greatly and has resulted in soils that may be classified as Regosols, Luvisols, Brunisols, or Gleysols. The humus forms are generally Hemi- and Hydromors or Mormoders.

The wettest ecosystems have developed on poorly drained organic soils derived from accumulated plant residues. The soils have been classified as Fibrisols, Mesisols, and Humisols while the humus forms are Histomors and Histomoders.

7.1.3 SBSe (Subalpine fir subzone)

7.1.3.1 Regional setting

The SBSe is the main timber-producing sub-boreal subzone in the Prince Rupert Region. This subzone occurs over most of the Nechako Plateau north of the Bulkley-Endako valley, and in this valley and the Lakes district (south of Burns Lake and Houston) occurs at elevations intermediate between the SBSd below and the Engelmann Spruce - Subalpine Fir Zone above. The SBSe ranges in elevation from 500 to 1050 m in the northern part of the study area, and from 850 to 1350 m in the southern part.

7.1.3.2 Climate

The subalpine fir subzone has the wettest, snowiest climate of the three SBS subzones in the Prince Rupert Region (Table 3). Not only does it snow more in the SBSe, but the snowpack also comes earlier and lasts longer. The SBSe is moister and cooler than the SBSd, which is especially significant during the growing season, and moister but warmer than the SBSa. Overall tree productivity in our three sub-boreal subzones is highest in the SBSe.

7.1.3.3 Vegetation

Subalpine fir, hybrid white spruce, and lodgepole pine are the major coniferous tree species in the SBSe. Black spruce, while common in wetlands, is infrequent but locally abundant in upland forest. Trembling aspen is a widespread seral deciduous species. Paper birch and black cottonwood are uncommon.

Forest stands in the subalpine fir subzone represent a mix of climax and seral stages. Subalpine fir and spruce (sometimes minor) dominate the climax stands. Lodgepole pine dominates or co-dominates most of the seral stands. Seral aspen forest is most abundant at lower elevations and on south slopes with heavier soils, especially so along the north shores of large lakes.

We characterize the mesic or zonal plant association of the SBSe as the *Picea glauca* x *engelmannii* - *Abies lasiocarpa* - *Cornus canadensis* - *Pleurozium schreberi* - *Ptilium crista-castrensis*. Seral variations of this widespread association include or often are dominated by lodgepole pine or aspen, but these seral species would eventually give way to the climax spruce and subalpine fir.

Mesic vegetation in this subzone has poorly to moderately developed herb and shrub layers; the relative development of these strata depend in part on the degree of canopy closure. Both strata are usually much less diverse, and overall much less leafy than in the SBSd. In contrast, the moss layer in mesic SBSe ecosystems is very well-developed, and typically forms a continuous, plush carpet of weft-forming mosses. Dominant bryophytes are much the same in both the SBSd and e. But, regarding minor species, *Rhytidiadelphus triquetrus* is uncommon while *Barbilophozia lycopodioides* is common in the SBSe; the reverse is true in the SBSd.

The presence and abundance of subalpine fir and *Vaccinium membranaceum*, especially on mesic sites, are important features of the SBSe, distinguishing it from both the SBSa and d. Also, as previously mentioned, moist rich ecosystems of the SBSe have *Oplopanax*, *Gymnocarpium*, *Athyrium*, *Dryopteris*, *Streptopus roseus*, and *Tiarella trifoliata*, all of which are lacking or uncommon in our other two sub-boreal subzones.

Natural grassland and scrub-grassland are rare or lacking in the SBSe; Rocky Mountain juniper is absent. Marshes, fens, and swamps are common throughout, but black spruce - *Ledum* - *Sphagnum* bogs are rare or lacking in the subalpine fir subzone.

7.1.3.4 Soils

Zonal ecosystems of the SBSe most commonly develop on morainal blankets; however, they may also occur on fluvial fans and fluvial and fluvialglacial terraces. Soil genesis is closely associated with texture of parent materials. Brunisols and Podzols develop on coarser materials, while Luvisols develop on the finer textured materials. Organic horizons range in total thickness from ca 5 to 15 cm and a fungal F horizon is usually dominant. The common humus form is a Hemimor.

The drier and nutrient-poor ecosystems often develop on coarse textured fluvial and fluvialglacial outwash, terraces, and fans, or occasionally on morainal or residual veneers over bedrock. The thin and crusty organic horizons are often Xeromors and, less frequently, Hemimors.

Moist, rich ecosystems develop on virtually all landforms in the SBS. An edaphic factor such as slope position or seepage can usually be identified to help explain the ecologic significance of the plant communities. Soil genesis is highly variable, as reflected in pedons classified in many subgroups of Brunisols, Luvisols, Gleysols, Podzols, and Regosols. Hemimors, Humimors, Mormoders, and Leptomoders, ranging in thickness from a few to more than 20 cm, are the most common humus forms.

The wettest ecosystems have poorly to very poorly drained organic blankets derived from plant residues in various stages of decomposition. The soils have been classified as Fibrisols and Mesisols and the humus forms are Histomors. The underlying mineral materials have not been studied.

ECOSYSTEM UNITS OF THE SUB-BOREAL SPRUCE ZONE (see Tables 5 and 6)

8.1 Introduction and Definitions

This guide concentrates on the identification and interpretation of ecosystem associations, subassociations, and phases. We follow a standardized format in the characterization and description of these ecosystem units for each subzone.

The description of each ecosystem association consists of three pages: a general description page, including photographs; a vegetation page; and a soils page. Descriptions of ecosystem subassociations and phases are often less detailed. Most of the information included in the ecosystem unit descriptions is self-explanatory, but some of the terms and symbols may require further explanation.

8.1.1 General description page

Ecosystem unit: ecosystem association, subassociation, phase, or variation; number and name. We use three types of names to label our ecosystem units: a code name (for computer purposes), a scientific name, and a colloquial name. By convention we designate the zonal or climatic climax ecosystem association as the first within a subzone, and the numbering then proceeds from dry to

Table 5. SYNOPSIS OF ECOSYSTEM UNITS OF THE SUB-BOREAL SPRUCE ZONE, SPRUCE SUBZONE (SBSd).

ECOSYSTEM ASSOCIATION				PHASE	
Code	Abbreviation*	Scientific Name	Common Name	Code	Common Name
SBSd/01	Pl - Sxw - (At) - ROSAACI LATHNEV - PLEUSCH	*Pinus contorta* - *Picea glauca* x *engelmannii* - (*Populus tremuloides*) - *Rosa acicularis* - *Lathyrus nevadensis* - *Pleurozium schreberi*	Mesic rose - peavine - moss	SBSd/01(a) SBSd/01(b)	Coarse textured phase Fine textured phase
SBSd/02	Pl - ARCTUVA - CLADONI	*Pinus contorta* - *Arctostaphylos uva-ursi* - *Cladoniae*	Pine - lichen		
SBSd/03	Pl - (Sxw) - SHEPCAN - ARCTUVA - PLEUSCH - CLADONI	*Pinus contorta* - (*Picea glauca* x *engelmannii*) *Shepherdia canadensis* - *Arctostaphylos uva-ursi* - *Pleurozium schreberi* - *Cladoniae*	Pine - lichen - moss		
SBSd/04	(JUNISCO) - AMELALN - SYMPALB - AGROTRA	(*Juniperus scopulorum*) - *Amelanchier alnifolia* - *Symphoricarpos albus* - *Agropyron trachycaulum*	Saskatoon - wheatgrass scrub/steppe		
SBSd/05	POA - STIPRIC - AGROTRA - BROMUS	*Poa* (*pratensis*, *gracillima*, *interior*) - *Stipa richardsonii* - *Agropyron trachycaulum* - *Bromus* (*carinatus*, *anomalus*)	Grassland		
SBSd/06	Fd - (Sxw) - SHEPCAN	*Pseudotsuga menziesii* - (*Picea glauca* x *engelmannii*) - *Shepherdia canadensis*	Douglas-fir - soopolallie		
SBSd/07	Pl - Sxw - ROSAACI - CORNCAN - PLEUSCH	*Pinus contorta* - *Picea glauca* x *engelmannii* - *Rosa acicularis* - *Cornus canadensis* - *Pleurozium schreberi*	Submesic bunchberry - moss		
SBSd/08	Sxw - Pl - (At) - ROSAACI - VIBUEDU - LATHNEV	*Picea glauca* x *engelmannii* - *Pinus contorta* - (*Populus tremuloides*) - *Rosa acicularis* - *Viburnum edule* - *Lathyrus nevadensis*	Moist shrub - forb		
SBSd/09	Sxw - LONIINV - CALACAN - EQUISET	*Picea glauca* x *engelmannii* - *Lonicera involucrata* - *Calamagrostis canadensis* - *Equisetum* (*arvense*, *sylvaticum*)	Spruce - horsetail	SBSd/09(a) SBSd/09(b)	Fluvial phase Lacustrine phase
SBSd/10	Ac - Sxw - CORNSER - LONIINV	*Populus balsamifera* ssp. *trichocarpa* - *Picea glauca* x *engelmannii* - *Cornus sericea* - *Lonicera involucrata*	Cottonwood bottomland		
SBSd/11	Sb - Sxw - BETUGLA - CAREDIS - TOMENIT	*Picea* (*mariana*, *glauca* x *engelmannii*) - *Betula glandulosa* - *Carex disperma* - *Tomenthypnum nitens*	Swamps		
SBSd/12	Sb - LEDUGRO - SPHACAP	*Picea mariana* - *Ledum groenlandicum* - *Sphagnum capillaceum*	Bogs		

* Standard B.C. Forest Service symbols designate the tree species (See Appendix 2).

Table 6. SYNOPSIS OF ECOSYSTEM UNITS OF THE SUB-BOREAL SPRUCE ZONE, SUBALPINE FIR SUBZONE, WESTERN VARIANT (SBSe1).

ECOSYSTEM ASSOCIATION				SUBASSOCIATION				PHASE	
Code	Abbreviation*	Scientific Name	Common Name	Code	Abbreviation	Scientific Name	Common Name	Code	Common Name
SBSe1/01	Sxw — Bl — CORNCAN — PTILCRI	*Picea glauca x engelmannii — Abies lasiocarpa — Cornus canadensis — Pleurozium schreberi — Ptilium crista-castrensis*	Mesic bunchberry — moss	SBSe1/01.1	Sxw — Bl — VACCMEM — CORNCAN — PLEUSCH — PTILCRI	*Picea glauca x engelmannii — Abies lasiocarpa — Vaccinium membranaceum — Cornus canadensis — Pleurozium schreberi — Ptilium crista-castrensis*	Mesic bunchberry — moss, black huckleberry subassociation	SBSe1/01.1(a) SBSe1/01.1(b)	Coarse textured phase Fine textured phase
				SBSe1/01.2	Sxw — Bl — CORNCAN — RUBUPED — PLEUSCH — PTILCRI	*Picea glauca x engelmannii — Abies lasiocarpa — Cornus canadensis — Rubus pedatus — Pleurozium schreberi — Ptilium crista-castrensis*	Mesic bunchberry — moss, five-leaved bramble subassociation	SBSe1/01.2(a) SBSe1/01.2(b)	Coarse textured phase Fine textured phase
SBSe1/02	Pl — ARCTUVA — CLADONI	*Pinus contorta — Arctostaphylos uva-ursi — Cladonias*	Pine — lichen						
SBSe1/03	Pl — (Bl) — VACCMEM — PLEUSCH — CLADONI	*Pinus contorta — (Abies lasiocarpa) — Vaccinium membranaceum — Pleurozium schreberi — Cladonias*	Pine — moss					SBSe1/03(a) SBSe1/03(b)	Coarse textured phase Lithic phase
SBSe1/04	Pl — Bl — Sxw — (VACCMEM) — CORNCAN — PLEUSCH	*Pinus contorta — Abies lasiocarpa — Picea glauca x engelmannii — (Vaccinium membranaceum) — Cornus canadensis — Pleurozium schreberi*	Submesic bunchberry — moss					SBSe1/04(a) SBSe1/04(b)	Coarse textured phase Fine textured phase
SBSe1/05	Pl — Sb — Sxw — VACCCAE — PLEUSCH	*Pinus contorta — Picea (mariana, glauca x engelmannii) — Vaccinium caespitosum — Pleurozium schreberi*	Pine — black spruce						
SBSe1/06	Sxw — (At) — (Bl) — VIBUEDU — RUBUPAR — RUBUPUB	*Picea glauca x engelmannii — (Populus tremuloides) — (Abies lasiocarpa) — Viburnum edule — Rubus (parviflorus, pubescens)*	Moist thimbleberry — forb						
SBSe1/07	Sxw — Bl — GYMNDRY — PLEUSCH — PTILCRI	*Picea glauca x engelmannii — Abies lasiocarpa — Gymnocarpium dryopteris — Pleurozium schreberi — Ptilium crista-castrensis*	Oak fern					SBSe1/07(a) SBSe1/07(b)	Coarse textured phase Fine textured phase
SBSe1/08	Bl — Sxw — OPLOHOR — GYMNDRY	*Abies lasiocarpa — Picea glauca x engelmannii — Oplopanax horridus — Gymnocarpium dryopteris*	Devil's Club					SBSe1/08(a) SBSe1/08(b)	Coarse textured phase Fine textured phase
SBSe1/09	Sxw — (Bl) — LONIINV — EQUISET	*Picea glauca x engelmannii — (Abies lasiocarpa) — Lonicera involucrata — Equisetum (arvense, sylvaticum, pratense)*	Horsetail flat					SBSe1/09(a) SBSe1/09(b)	Coarse textured phase Fine textured phase
SBSe1/10	Sb — SALIX — BETUGLA — CAREX — SPHACAP — TOMENIT	*Picea mariana — Salix (barclayi, glauca) — Betula glandulosa — Carex (aquatilis, disperma) — Sphagnum capillaceum — Tomenthypnum nitens*	Black spruce fen and swamp						

* Standard B.C. Forest Service symbols designate the tree species (see Appendix 2).

wet e.a.s. We designate subassociations and variations numerically and phases alphabetically.

E.g.) SBSel/01.1(a) - is the code name for the zonal ecosystem association (01); *Vaccinium membranaceum* subassociation (.1); coarse textured phase (a) of the SBSel.

We scientifically name ecosystem associations by the dominant plant species that occur in maturing seral to climax vegetation. Species are listed in the order trees, shrubs, herbs, mosses or lichens, and usually we use 1 or 2 species per layer.

E.g.) *Picea glauca* x *engelmannii* - *Abies lasiocarpa* - *Cornus canadensis* - *Pleurozium schreberi* - *Ptilium crista-castrensis* is the scientific name of the climatic climax ecosystem association of the SBSel, the SBSel/01. Less frequent or abundant species are put in parentheses.

We also offer a colloquial name for ecosystem units, as an aid to those not used to scientific names.

E.g.) *Picea glauca* x *engelmannii* - *Abies lasiocarpa* - *Cornus canadensis* - *Pleurozium schreberi* - *Ptilium crista-castrensis* = Mesic bunchberry - moss ecosystem association.

Ecological moisture regime: refers to the relative amount of moisture available for plant growth. See Table 1 for a synopsis of moisture regime classes.

Ecological nutrient regime: refers to the relative amounts of nutrients available for plant growth. See Table 2 for a synopsis of nutrient regime classes.

Edatopic grid position: the small grid indicates ecological moisture regime (1-7) on its vertical axis and ecological nutrient regime (A-E) on its horizontal axis. The size of each rectangle within the grid approximates the relative extent of the corresponding moisture/nutrient regime in the appropriate subzone of the SBS. The shaded area on the grid indicates the range of moisture and nutrient conditions over which the ecosystem unit develops. Enlarged versions of the grid, properly labelled for each subzone, appear in Figures 7 and 9.

Distribution: gives a general idea of how common the ecosystem unit is and where it occurs within a subzone.

Physiographic features: summarizes typical or common physical site characteristics and indicates where in the landscape one may expect to find the ecosystem unit. This section utilizes terms and descriptions in general usage (see the manual, Describing Ecosystems in the Field by Walmsley et al. 1980).

Strata coverage: presents the average percent coverage of the ground surface by the vertically projected crowns of all plants in the tree (A); shrub (B); herb (C); and moss (D) layers, respectively.

Ground coverage: evaluates the surface substrate of ecosystem units as the average percentages of the ground surface covered by organic matter or humus (H); bare mineral soil (MS); decaying wood (DW); and bedrock and stones (R&S), respectively.

8.1.2 Vegetation page

The vegetation page lists the most abundant or characteristic plant species in the ecosystem unit, and may comment on some relevant feature of the plants. Characteristic species are those found frequently and often abundantly in vegetation stands roughly 80 years old or older (i.e., maturing seral to climax stands). Each species is listed by its scientific (Latin) name and a common name, if such exists. Scientific nomenclature follows Taylor and MacBryde (1977, 1978) for the vascular plants; Crum et al. (1973) for the mosses; Stotler and Crandall-Stotler (1977) for the liverworts; and Hale and Culberson (1970) for the lichens. Common names correspond with those used in the publication "Some Common Plants of the Sub-Boreal Spruce Zone" by Pojar et al. 1982, which is designed to be used in conjunction with this guide. Appendix 1 contains a list of both scientific and common names of all the plant species that appear in this guide.

The plants are listed according to vegetation 'strata' or layers which are defined as follows:

Tree Layer: contains woody plants exceeding 10 m in height. In extreme habitats, such as bogs, tree species are often stunted and less than 10 m tall. However, we still list them in the tree layer and comment on their reduced height. Note that the tree species listed represent those found in mature climax or at least advanced successional stands (unless otherwise indicated). Young stands may have a very different species composition.

Shrub Layer: contains woody plants between approximately 30 cm and 10 m in height. We list seedlings and saplings of tree species in the shrub layer, as regeneration. Tree regeneration is always listed first in this layer, regardless of its abundance.

Herb Layer: contains all herbaceous (non-woody) plants, including ferns, plus all trailing woody plants and dwarf shrubs that do not normally exceed 30 cm in height. For example, the dwarf shrub Arctostaphylos uva-ursi (kinnikinnick) is always included in the herb layer because of its creeping growth habit.

Moss Layer: includes mosses, liverworts, and lichens growing on the forest floor. Note that unless otherwise indicated in the comments, we do not include species growing on decaying wood or on living plants. We do not list common names for most species in this layer.

Within each layer, the species are listed more or less in order of importance, although of course this varies from site to site in the field. The list does not include all species found in an ecosystem unit, just those that are most common or most important in terms of cover or indicator value. Cover refers to the abundance or percentage of ground surface occupied or covered by the plant crown. Indicator value refers to how much a plant can tell you about the growing conditions on the site. Some plants, like Cornus canadensis (bunchberry) are relatively poor indicators because they will grow almost anywhere. Other plants, such as Ledum groenlandicum (Labrador tea) have restricted habitats and therefore are good indicators of site conditions such as moisture, nutrients, and light. Where appropriate we have commented on the indicator value of species. These comments apply only to the study area. In other areas, in different conditions, the response of the same species may be different or less obvious.

Species enclosed in square brackets [ ] either have low cover, or are not consistently present. They are less important than species without brackets.

Species marked by an asterisk appear to be seral in the relevant ecosystem associations.

The abbreviation sp. after the name of a plant genus (e.g., *Viola* sp.) refers to a single, unknown species, while spp. refers to several unnamed species belonging to the genus (e.g., *Sphagnum* spp.). Occasionally we recognize subdivisions of a species, called subspecies. These are abbreviated ssp. (e.g., *Alnus viridis* ssp. *sinuata*).

8.1.3 Soils page

The soils page attempts to summarize those soil features which aid in classification and identification of the ecosystem unit. In many cases, soil profiles described within an ecosystem association are extremely variable. Similarities between soil features such as texture, colour, volume of coarse fragments, and depth of organic layers may aid in the identification of an ecosystem unit. A brief description of the soil page format follows.

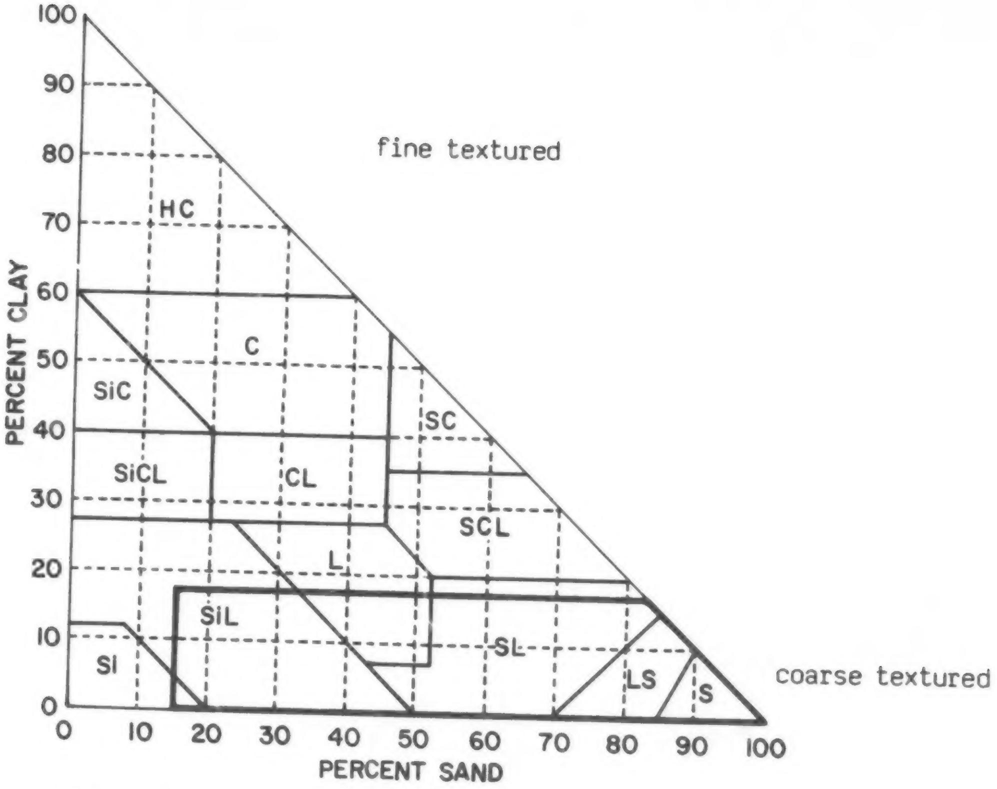
General description: includes a paragraph summarizing the basic morphological and genetic features of the soil pedon, such as colour, texture, depth of humus, drainage, etc. These are the features that would appear most obvious to an observer standing back and looking into the soil pit.

Associated classifications: several groups of related soil classifications are presented that have been recorded during field plot work, or have been arrived at through a combination of field sampling and subsequent laboratory analysis. These classifications are of soil (Canada Soil Survey Committee 1978), humus form (Klinka et al. 1981), terrain (British Columbia Environment and Land Use Committee Secretariat 1978), parent materials and, when applicable, bedrock geology.

Schematic profile: a diagrammatic presentation of a "typical" soil profile within an ecosystem unit is given, with approximate depths varying to 1 m. Horizon designations and a brief description of sequential horizons are also given. The most important morphological features of the horizons are mentioned such as colour, texture, structure, abundance of roots, presence or absence of mottling, and underlying horizons or parent materials. Brackets around a horizon designation (e.g., Bm) are used to suggest the horizon may occur, but not frequently or in the suggested order. Colour names used in profile descriptions come from the standard Munsell Soil Colour Charts. For a breakdown of sand (S), silt (Si) and clay (C) into textural classes, refer to the textural triangle in Fig. 6.

Key Characteristics: this includes, in point form, the most obvious features that may help to distinguish soils of a particular ecosystem unit, and that may at times be the most silviculturally significant. This section focuses on some of the key features that recurred in those profiles studied within a particular unit.

A brief concluding section (Comments) may follow.



Soil texture classes. Percentages of clay and sand in the main textural classes of soil; the remainder of each class is silt.

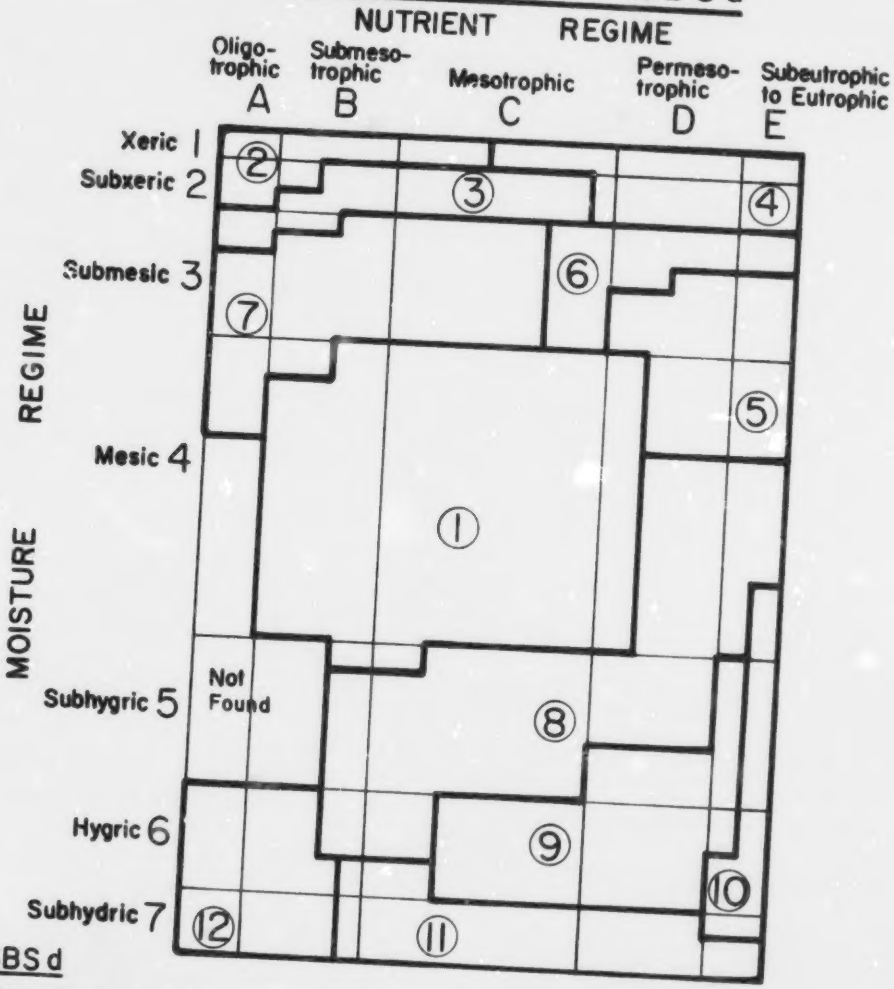
Figure 6. Soil textural triangle. Subdivision of the triangle into coarse and fine textured portions is intended to correspond to family particle-size classes (Canadian Soil Survey Committee 1978: Fig. 36), whereby relatively coarse textured soils have sandy or coarse-loamy family particle sizes, and everything else is relatively fine textured.

8.2 ECOSYSTEM UNITS OF THE SBSd: SPRUCE SUBZONE

- /01 Mesic rose - peavine - moss ecosystem association
  - /01(a) Coarse textured phase
  - /01(b) Fine textured phase
  - /01 Aspen variation
- /02 Pine - lichen ecosystem association
- /03 Pine - lichen - moss ecosystem association
- /04 Saskatoon - wheatgrass scrub/steppe ecosystem association
- /05 Grassland ecosystems
- /06 Douglas-fir - soopolallie ecosystem association
- /07 Submesic bunchberry - moss ecosystem association
- /08 Moist shrub - forb ecosystem association
- /09 Spruce - horsetail ecosystem association
  - /09(a) Fluvial phase
  - /09(b) Lacustrine phase
- /10 Cottonwood bottomland ecosystem association
- /11 Swamp ecosystems
- /12 Bog ecosystems

Figure 7.

Edatopic Grid of Ecological Moisture and Nutrient Regime -SBSd


NUTRIENT REGIME
Oligo-trophic A
Submeso-trophic B
Mesotrophic C
Permeso-trophic D
Subeutrophic to Eutrophic E
MOISTURE REGIME
Xeric 1
Subxeric 2
Submesic 3
Mesic 4
Subhygric 5
Hygric 6
Subhydric 7
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
Not Found

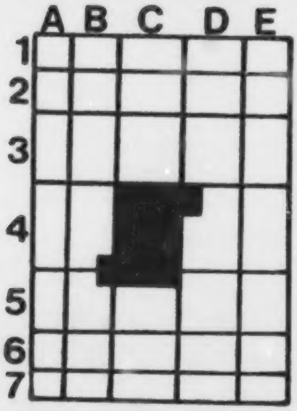
SBS d

① Mesic Rose - Peavine - Moss
② Pine - Lichen
③ Pine - Lichen - Moss
④ Saskatoon-Wheatgrass-Scrub/Steppe
⑤ Grassland Ecosystems
⑥ Douglas-fir - Soopolallie
⑦ Submesic Bunchberry - Moss
⑧ Moist Shrub - Forb
⑨ Spruce - Horsetail
⑩ Cottonwood Bottomland
⑪ Swamps
⑫ Bogs

SBSd/01 MESIC ROSE - PEAVINE - MOSS

BIOGEOCLIMATIC UNIT: SBSd

ECOSYSTEM UNIT: SBSd/01; *Pinus contorta* - *Picea glauca* x *engelmannii* - (*Populus tremuloides*) - *Rosa acicularis* - *Lathyrus nevadensis* - *Pleurozium schreberi*; Mesic rose - peavine - moss ecosystem association.



ECOLOGICAL MOISTURE REGIME: Mesic

ECOLOGICAL NUTRIENT REGIME: Mesotrophic - Permesotrophic

DISTRIBUTION: Widespread throughout the subzone.

PHYSIOGRAPHIC FEATURES:
Slope Positions: Middle slopes usually, sometimes upper or lower.
Slope Range: 0 to 30% Aspect: All
Surface Shape: Variable, straight, slightly concave or convex.

STRATA COVERAGE (%): A: 52 B: 30 C: 53 D: 74

GROUND COVERAGE (%): H: 92 MS: 0 DW: 8 R&S: trace

SBSd/01 MESIC ROSE - PEAVINE - MOSS

VEGETATION:

Tree Layer: stands usually well-stocked.

Picea glauca x engelmannii	(hybrid white spruce)
*Pinus contorta	(lodgepole pine)
[*Populus tremuloides	(trembling aspen)]

Shrub Layer: poorly to moderately developed; mostly low shrubs except for scattered tree regeneration.

P. glauca x engelmannii		-regeneration
Rosa acicularis	(prickly rose)	)
[Spiraea betulifolia	(birch-leaved spirea)]	) -all with
[*Amelanchier alnifolia	(Saskatoon)]	) merely poor
[*Shepherdia canadensis	(soopolallie)]	) to fair
[*Viburnum edule	(highbush-cranberry)]	) vigour
[*Lonicera involucrata	(black twinberry)]	)

Herb Layer: usually well-developed and vigourous.

Lathyrus nevadensis	(purple peavine)	-characteristic dominant, although not always present
Aster conspicuus	(showy aster)	
Cornus canadensis	(bunchberry)	
Linnaea borealis	(twinflower)	
*Epilobium angustifolium	(fireweed)	
Arnica cordifolia	(heartleaved arnica)	
[Rubus pubescens	(trailing raspberry)]	
[*Aster ciliolatus	(fringed aster)]	
[Calamagrostis canadensis	(bluejoint)]	

Moss Layer: usually well-developed but often obscured by the lush herb layer.

Pleurozium schreberi	(red-stemmed feather moss)	) -codominants
Ptilium crista-castrensis	(knight's plume feather moss))	
Hylocomium splendens		
[Rhytidiadelphus triquetrus]		

SBSd/01(a) MESIC ROSE - PEAVINE - MOSS, COARSE TEXTURED PHASE

SOILS:

General Description: Soils in this phase are coarse textured, gravelly, to skeletal, and have developed on ice-contact and glacial deposits. The organic layer is usually dominated by a moderately decomposed F horizon with fungal mycelia common to abundant. A yellowish brown to brown Bm horizon(s) with weak structure is evident in the mineral soil profile and may be overlain by a light brownish gray Ae horizon. Effective rooting is relatively deep (40 to 70 cm), generally to the bottom of the Bm horizon. Luvisolic (Bt) development is rare in this phase. Drainage is moderately good to rapid. This phase may occur on crest to lower slope positions.

Associated Classifications:

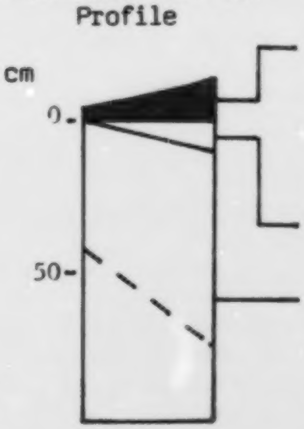
Soil: Orthic and Eluviated Dystric Brunisols (occasional Brunisolic Gray Luvisol)

Terrain: Eskers, morainal blankets

Parent Materials: Coarse ice-contact and glacial deposits

Humus Form: Hemimors (Mormoders)

Schematic Profile:



Horizon	Description
(L), F, (H)	-scattered litter among mosses; a dominant, moderately decomposed F with fungal mycelia common to abundant; abundant roots; a thin well decomposed H horizon may be present.
Ae	-light brownish gray; loamy sand; weak structure; plentiful roots.
Bm	-yellowish brown to brown; sandy to loamy, weak structure; plentiful roots over a BC or C horizon with very few to no roots.

Key Characteristics:
- coarse texture
- gravelly to skeletal

SBSd/01(b) MESIC ROSE - PEAVINE - MOSS, FINE TEXTURED PHASE

SOILS:

General Description: Soils in this phase are fine textured and have developed on morainal blankets. Invariably, these soils have a Bt horizon (characterized by clay skins) that can restrict roots, water, and air. Generally a Bm horizon is above the Bt, and at times an Ae horizon can be distinguished. The organic layer is dominated by the F horizon which typically has common mycelia and a slightly matted fabric. The role of fire in these ecosystems probably accounts for variability of the morphologic characteristics in the organic horizons. The pedons are well to imperfectly drained, usually occurring on the midslope.

Associated Classifications:

Soil: Brunisolic (minor Orthic, Gleyed Brunisolic, and Dark) Gray Luvisols

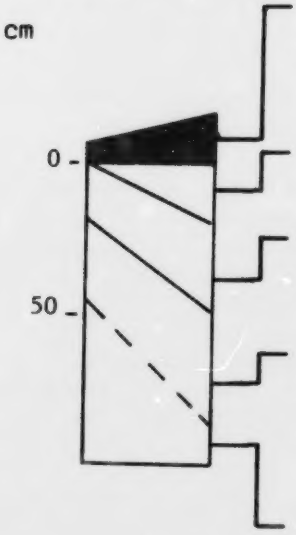
Humus Form: Hemimors (Mormoders and Leptomoders infrequently)

Terrain: Morainal blankets

Parent Materials: Glacial till

Schematic Profile:

Profile



Horizon	Description
(L), F, (H)	-scattered and mixed litter on a moderately decomposed F horizon; slightly compact-matted with mycelia common; may be over a thin, well decomposed H.
(Ae)	-grayish brown; loam; subangular blocky; few to plentiful roots.
Bm	-brown to dark grayish brown; sandy loam to sandy clay loam; subangular blocky; plentiful roots.
Bt(gj)	-brown to grayish brown; sandy clay loam to clay; (yellowish brown, faint mottles); clay skins on peds and in pores; medium to coarse subangular blocky; few to very few roots.
BC	-dark grayish brown to brown; clay loam; very few to no roots.

Key Characteristics:

- fine textures
- morainal blankets
- Bt horizons, usually restrictive to roots, water and air

SBSd/01 MESIC ROSE - PEAVINE - MOSS

The SBSd/01 is the zonal ecosystem association of the spruce subzone of the Sub-Boreal Spruce Biogeoclimatic Zone. That is, the Mesic rose - peavine - moss e.a. consists of a group of closely related ecosystems that best reflect the regional climate of the land area we have classified and mapped as the SBSd. The SBSd/01 occupies habitats that are more or less average for the subzone; i.e., with generally mesic moisture conditions and mesotrophic nutrient conditions. Usually these conditions obtain on moderate, middle slopes of all aspects. Such habitats are the norm in the undulating, morainal, plateau landscape that characterizes the SBSd. Thus, the Mesic rose - peavine - moss ecosystem association is widespread throughout the subzone and covers more area than any other e.a.

Most SBSd/01 ecosystems are in some successional stage, having been burned at least once within the past 100 to 150 years. Relatively few forest stands have reached the theoretical climax state. Most commercial stands that we have sampled were between 80 and 150 years old. Such forests are usually mixtures of hybrid white spruce and lodgepole pine with variable amounts of trembling aspen. Spruce is the climax tree species and increases in relative abundance with increasing stand age, but pure stands of spruce on mesic sites are rare. Mature stands belonging to the SBSd/01 are usually fairly well-stocked, but also often have fairly open, irregular canopies.

The shrub layer is poorly to moderately developed, and consists mostly of low shrubs except for common but scattered regenerating spruce. Rosa acicularis is the most consistently present shrub. Other common species are Shepherdia canadensis, Viburnum edule, and Lonicera involucrata, all of which exhibit merely poor to fair vigour.

Lathyrus nevadensis most often dominates the well-developed, vigourous herb layer, although this species is not always present. Other typical species include *Aster conspicuus*, *Cornus canadensis*, *Linnaea borealis*, *Epilobium angustifolium*, and *Arnica cordifolia*. *Rubus pubescens*, *Aster ciliolatus*, *Calamagrostis canadensis*, and *Smilacina racemosa* are also common.

The moss layer is usually well-developed but often obscured by a lush herb layer. *Pleurozium schreberi* and *Ptilium crista-castrensis* codominate, while *Hylocomium splendens*, *Rhytidiadelphus triquetrus*, and *Peltigera aphthosa* are also common.

Sometimes at higher elevations in the drier southern parts of the SBSd, the shrub and herb layers of the Mesic rose - peavine - moss ecosystem association thin out considerably. In these cases the mesic ecosystems take on more of the aspect of a spruce - moss type, with poorly developed shrub and herb layers. To some extent these changes are related to variable successional status, but the decreasing lushness of the shrub and herb cover seems also to be a response to a slightly drier and colder climate in these areas, which are somewhat transitional to the SBSa.

The SBSd/01 is the most common and abundant ecosystem association of the spruce subzone. Hence it includes a fairly wide range of variation in physiography, soil, and vegetation. It is necessary to recognize some of this variation, especially for management purposes.

Soil Phases

We have distinguished two phases based on soil texture.

SBSd/01(a) Coarse textured phase

This phase has developed on coarse, sometimes skeletal, parent materials of morainal or ice-contact fluvialglacial origin. The soils are moderately well to rapidly drained and occur on crest to lower slope positions. A yellowish brown to brown Bm horizon dominates the upper mineral profile and may be overlain by a thin, leached Ae horizon, resulting in Orthic and Eluviated Dystric Brunisols. Coarse textured Brunisolic Gray Luvisols are uncommon but do occur. A fungal, moderately decomposed F horizon makes up the bulk of the organic horizons (Hemimors) with scattered litter on top of or intermixed with the moss layer. A thin H horizon may be present and we generally think that many of the H horizons in the SBSd are a result of further decomposition of the residual "pre-fire" F horizon of the previous stand. The H horizon commonly contains charcoal; the horizon's boundary is sharply delineated from the underlying mineral soil, but often adheres to it. The average pH[1] of the composite organic horizons was 4.2 and the weighted average pH of the mineral soil horizons in the effective rooting zone (Walmsley et al. 1980) was 4.9. See Figure 8 for comparisons of pH values among SBSd ecosystem associations.

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[1] The pH values in this report are composite and weighted averages of the organic horizons and effective rooting zones in the mineral horizons. All pH values were determined for organic samples in 1:10 .01M $CaCl_2$ and for mineral samples in 1:2 .01M $CaCl_2$, using a Fisher Accumet Model 424 (Kelowna Soil Laboratory) or Model 425 (Ministry of Forests Smithers Soils Laboratory).

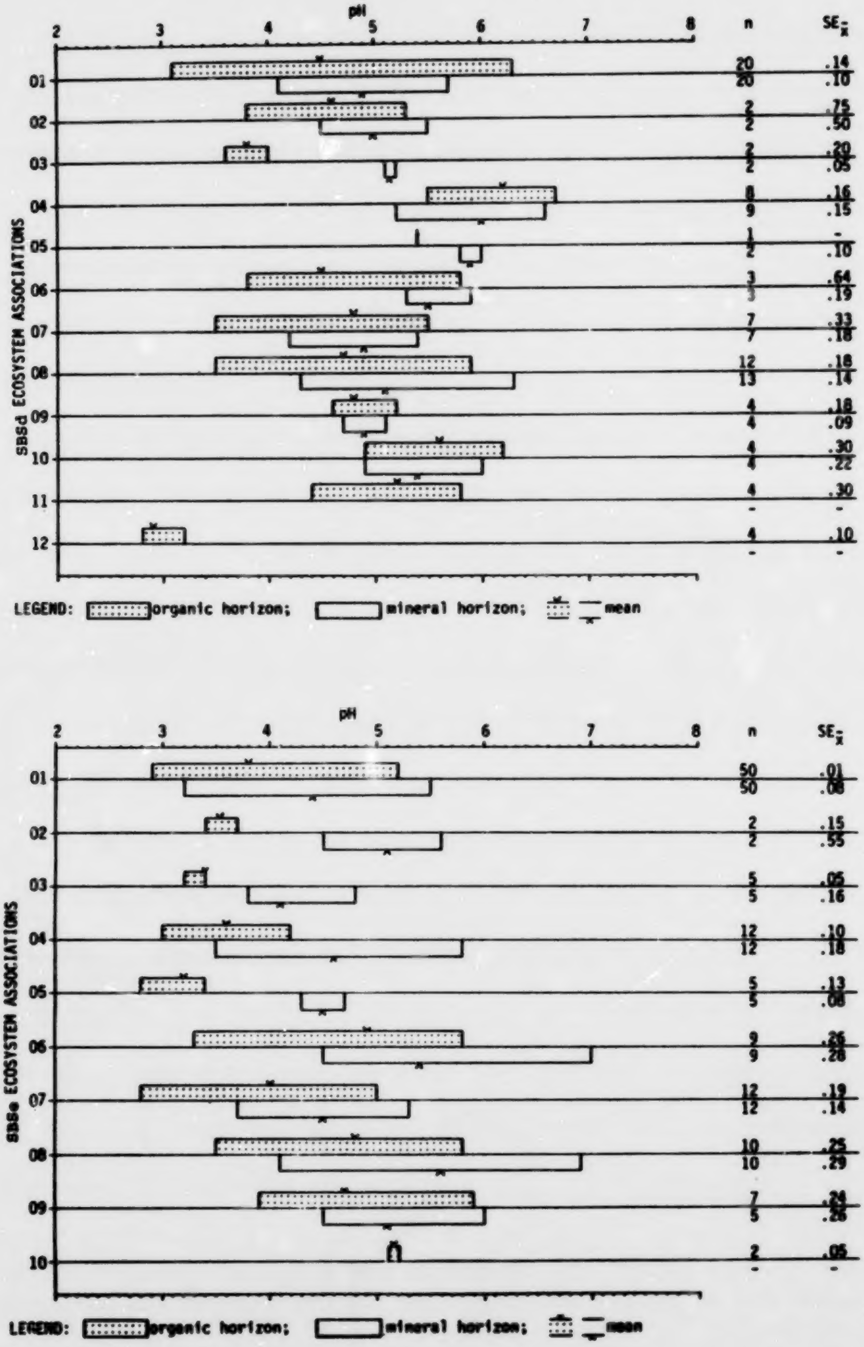


Figure 8. Values of pH in the effective rooting zone of the SBSd and e ecosystem associations.

SBSd/01(b) Fine textured phase

The soils of this phase have developed on finer textured morainal blankets. Downward movement of clays has been the overriding genetic characteristic of profile development. The Bt horizon(s) has well-developed clay skins on ped faces, in pores, and channels. Clay skins on coarse fragments may be genetic; however, some B.C. pedologists think that these may be remnants of original till material or even the result of freeze-thaw cycles (T. Lord and K. Valentine, personal communications). Ae horizons can at times be distinguished, particularly when dry, and Bm horizons are commonly found over the Bt horizon(s). Some profiles show common, faint, yellowish brown mottles in the Bt(gj). Although Bt horizons in the SBSd show stronger structural development than in the SBSe, these horizons can be very restrictive to roots and movement of water and air. While helping to describe a luvisolic soil in the SBSd, C. Wang, of the Land Resource Research Institute, Ottawa, suggested that some of our Bt's may be fragic (Btx). The same soil showed free carbonates at a depth not commonly reached in field soil pits. Underlying parent materials (BC and C horizons) are often compact, deep, and very difficult to dig.

Humus forms are similar to those of the coarse textured phase; however, Mormoders and Leptomoders may also occur. The nature of organic materials in mesic ecosystems is highly variable due to variable effects of fire and duration of seral vegetation.

Values of pH's were 4.5 for the organic horizons and 4.9 for the mineral horizons.

Successional Variation in Vegetation

The ubiquitous fire history of the SBS has produced a diverse array of successional plant communities on many zonal sites. Species composition and vegetation structure are continually changing with time throughout succession. We have not sampled enough seral ecosystems to describe them properly or to chronicle their succession (see Runka 1972; Cotic et al. 1974). However, there are some general features of the vegetation that help characterize the most widespread seral stages of the SBSd/01.

SBSd/01: Aspen - dominated seral stages

Trembling aspen dominates these stages. Pure stands of aspen are common in the SBSd, but there may also be mixtures of aspen with lodgepole pine and minor hybrid white spruce.

Species such as *Rosa acicularis*, *Amelanchier alnifolia*, *Spiraea betulifolia*, *Rubus parviflorus*, *Salix bebbiana*, *S. scouleriana*, *Shepherdia canadensis*, and *Symphoricarpos albus* typify the well-developed shrub layer.

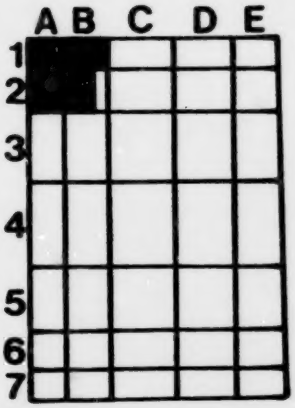
The herb layer is usually very well-developed, lush, and diverse. Common species include *Lathyrus nevadensis*, *L. ochroleucus*, *Aster conspicuus*, *A. ciliolatus*, *Epilobium angustifolium*, *Viola canadensis*, *Thalictrum occidentale*, *Galium boreale*, *Fragaria virginiana*, *Geranium richardsonii*, *Delphinium glaucum*, *Heracleum sphondylium*, *Elymus glaucus*, and *Schizachne purpurascens.*

The moss layer is usually poorly developed or lacking.

SBSd/02 PINE - LICHEN

BIOGEOCLIMATIC UNIT: SBSd

ECOSYSTEM UNIT: SBSd/02; *Pinus contorta* - *Arctostaphylos uva-ursi* - *Cladoniae*; Pine - lichen ecosystem association.



ECOLOGICAL MOISTURE REGIME: Xeric - subxeric

ECOLOGICAL NUTRIENT REGIME: Oligotrophic - submesotrophic

DISTRIBUTION: Uncommon in the study area.

PHYSIOGRAPHIC FEATURES:
Slope Positions: Level or crest, located on or around exposed bedrock.
Slope Range: 0 to 60%
Surface Shape: Convex or straight (flat).
Aspect: Variable; if on slope tends to be southerly.

STRATA COVERAGE (%): A: 25 B: 44 C: 35 D: 45

GROUND COVERAGE (%): H: 90 MS: 5 DW: 1 R&S: 4

SBSd/02 PINE - LICHEN

VEGETATION:

Tree Layer: open stands of poorly growing trees.
Pinus contorta (lodgepole pine)

Shrub Layer: sparse.
Pinus contorta -regeneration
[*Juniperus communis* (common juniper)]

Herb Layer: sparse.
Arctostaphylos uva-ursi (kinnikinnick)

Moss Layer: moderately well-developed, dominated by lichens.
Cladina spp. (reindeer lichens)
Cladonia spp.

Comments: the relative abundance of *Arctostaphylos uva-ursi* and the dominance of the "moss" layer by lichens rather than mosses are diagnostic for the Pine - lichen ecosystem association.

SBSd/02 PINE - LICHEN

SOILS:

General Description: Those soils which we have sampled in this ecosystem association are on colluvial slopes derived from basic bedrock types. Organic horizons are thin and crusty when dry. A Bm (Bfj) horizon develops in the profile over colluvial or bedrock parent materials. Pedons are rapidly drained on upper slope positions.

Associated Classifications:

Soil: Orthic Eutric and Dystric Brunisols

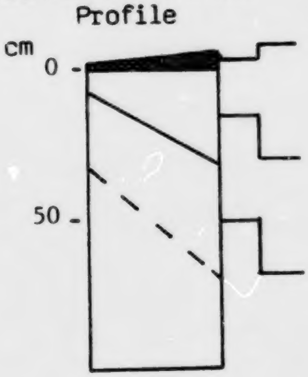
Humus Form: Xeromors

Terrain: Colluvial veneer over bedrock

Parent Materials: Colluvium from basic bedrock types.

Bedrock Geology: Gabbro and Basalt sampled.

Schematic Profile:



Horizon	Description
L, F	-scattered, loose litter over a partially decomposed F horizon; crusty when dry.
Bm(Bfj)	-yellowish to very dark grayish brown; loamy sand to sandy loam; weak structure; plentiful roots.
(BC/C)	-brown; sand; single grain; few roots; over bedrock.

Key Characteristics:
- shallow colluvial soils over bedrock
- thin organic horizons, crusty when dry

Comments: Sampling has been very limited.

SBSd/02 PINE - LICHEN

The Pine - lichen ecosystem association represents habitats that are among the driest and poorest in the spruce subzone of the SBS.

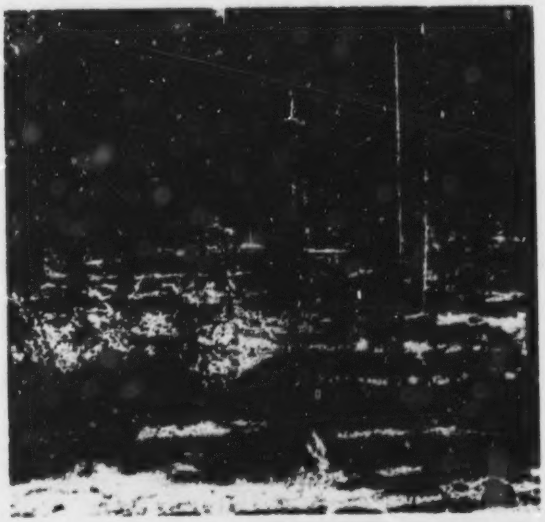
Poorly growing lodgepole pine forms the open stands typical of this fire-climax ecosystem association. The shrub layer is sparse and formed mainly of pine regeneration and *Juniperus communis*. *Arctostaphylos uva-ursi* is most typical of the equally sparse dwarf shrub/herb layer. The ground cover or moss layer is moderately developed and dominated by 'fruticose' (miniature shrub-like) lichens, especially species of *Cladina*, *Cladonia* and *Stereocaulon*. The dominance of the ground cover by lichens rather than mosses or herbs is diagnostic for the SBSd/02. Those mosses that do occur are usually on exposed rocks or decaying wood.

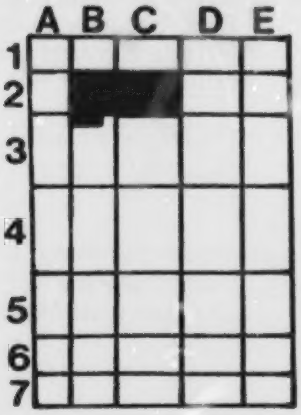
The soils have developed as Orthic Eutric and Dystric Brunisols on colluvial veneers over basic bedrock types. A medium to coarse textured Bm or Bfj is found under a thin, crusty Xeromor. The BC/C horizon may be relatively close to the surface and bedrock is usually within one meter of the surface. This ecosystem association is found on upper and crest slope positions where drainage is rapid. It may also occur on coarse textured, rapidly drained fluvial and fluvioglacial deposits, but we did not sample such a combination. The pH of the organic horizons was 4.5 and of the mineral rooting zone was 5.5.

SBSd/03 PINE - LICHEN - MOSS

BIOGEOCLIMATIC UNIT: SBSd

ECOSYSTEM UNIT: SBSd/03; *Pinus contorta* - (*Picea glauca* x *engelmannii*) - *Shepherdia canadensis* - *Arctostaphylos uva-ursi* - *Pleurozium schreberi* - *Cladoniae*; Pine - lichen - moss ecosystem association.





ECOLOGICAL MOISTURE REGIME: Subxeric

ECOLOGICAL NUTRIENT REGIME: Submesotrophic -mesotrophic

DISTRIBUTION: Scattered throughout the subzone but relatively uncommon.

PHYSIOGRAPHIC FEATURES:
Slope Positions: Level or upper slope and crest; on fluvial/glaciofluvial deposits or around bedrock outcrops.
Slope Range: 0 to 20%
Surface Shape: Straight (flat) or convex.
Aspect: Level or, if on slope, tending to southerly.

STRATA COVERAGE (%): A: 34 B: 13 C: 45 D: 75

GROUND COVERAGE (%): H: 95 MS: 0 DW: 5 R&S: 0

SBSd/03 PINE - LICHEN - MOSS

VEGETATION:

Tree Layer: stands usually understocked, with fairly open canopies; poor tree growth.

Pinus contorta	(lodgepole pine)
Picea glauca x *engelmannii*	(hybrid white spruce)
Populus tremuloides	(trembling aspen)

Shrub Layer: poorly developed; low shrubs except for tree regeneration.

P. contorta		)
[*P. glauca* x *engelmannii*]		) -regeneration
[*P. tremuloides*]		)
Shepherdia canadensis	(soopolallie)	-fair vigour
[*Rosa acicularis*	(prickly rose)]	-poor vigour

Herb Layer: poorly to moderately developed.

**Arctostaphylos uva-ursi*	(kinnikinnick)	-characteristic dominant
Linnaea borealis	(twinflower)	
[*Oryzopsis asperifolia*	(rough-leaved rice grass)]	
[**Oryzopsis pungens*	(short-awned rice grass)]	-good indicator if present
[*Vaccinium caespitosum*	(dwarf blueberry)]	

Moss Layer: moderately well-developed; diverse.

Pleurozium schreberi	(red-stemmed feather moss)
**Cladina rangiferina*	(reindeer lichen)
**Cladina mitis*	
[*Dicranum polysetum*]	
[*Peltigera* spp.]	
[*Cladonia* spp.]	

Comments: the Pine - lichen - moss ecosystem association is much more common than the Pine - lichen e.a., has less *Arctostaphylos uva-ursi*, and has an abundance of both mosses and lichens on the forest floor.

SBSd/03 PINE - LICHEN - MOSS

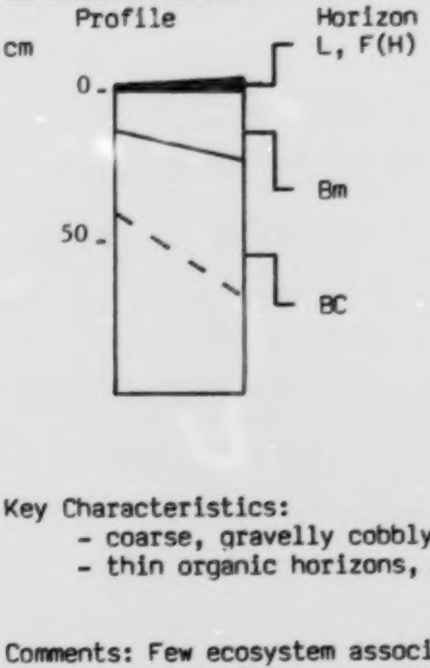
SOILS:

General Description: Soils in this ecosystem association are coarse textured and skeletal, having developed on fluvialglacial terraces and over gravelly, cobbly, and usually well sorted parent materials. Organic horizons are thin (less than 5 cm thick), loose, crusty when dry, and are made up largely of needles and lichens. The mineral horizons show weak development. A Bm, or series of Bm horizons, is reddish to dark yellowish brown over a BC or C horizon. Effective rooting depth approximates the lower boundary of the Bm horizon. The pedons are rapidly to very rapidly drained on level to very gently sloping landscapes.

Associated Classifications:

Soil: Orthic Dystric Brunisols	Terrain: Fluvialglacial terraces
Humus Form: Xeromors	Parent Materials: Coarse gravelly and cobbly fluvial sediments

Schematic Profile:



Description

-litter of needles and lichens, over a partially decomposed F horizon made up mostly of needle fragments. A very thin crumbly H horizon may be present.

-reddish to dark yellowish brown, loamy sand; skeletal; weak subangular blocky; abundant to plentiful fine roots.

-brown to dark brown; sand; skeletal; single grain; very few roots over unaltered parent materials.

Key Characteristics:
- coarse, gravelly cobbly, fluvialglacial terraces
- thin organic horizons, crusty when dry

Comments: Few ecosystem associations in the SBS support colonies of ants; however, ant hills are very common in the SBSd/03.

SBSd/03 PINE - LICHEN - MOSS

The SBSd/03 or Pine - lichen - moss ecosystem association is similar to the SBSd/02, but generally not as dry or nutrient-poor. It is much more common than the Pine - lichen e.a. The SBSd/03 occurs on rapidly drained, coarse textured (skeletal) fluvial and colluvial deposits, or on shallow soil over bedrock.

Lodgepole pine dominates the fairly open stands, which often include trembling aspen and hybrid white spruce. Tree growth is relatively poor.

The shrub layer is poorly developed and, except for some tree saplings, consists of low shrubs. Pine regeneration is common, young spruce and aspen are infrequent. *Shepherdia canadensis* and *Rosa acicularis* are characteristic shrubs. *Juniperus communis* is sometimes common.

Arctostaphylos uva-ursi is the characteristic dominant in the poorly to moderately developed dwarf shrub/herb layer. Also common are *Linnaea borealis*, *Vaccinium caespitosum*, *Oryzopsis asperifolia*, and *O. pungens*.

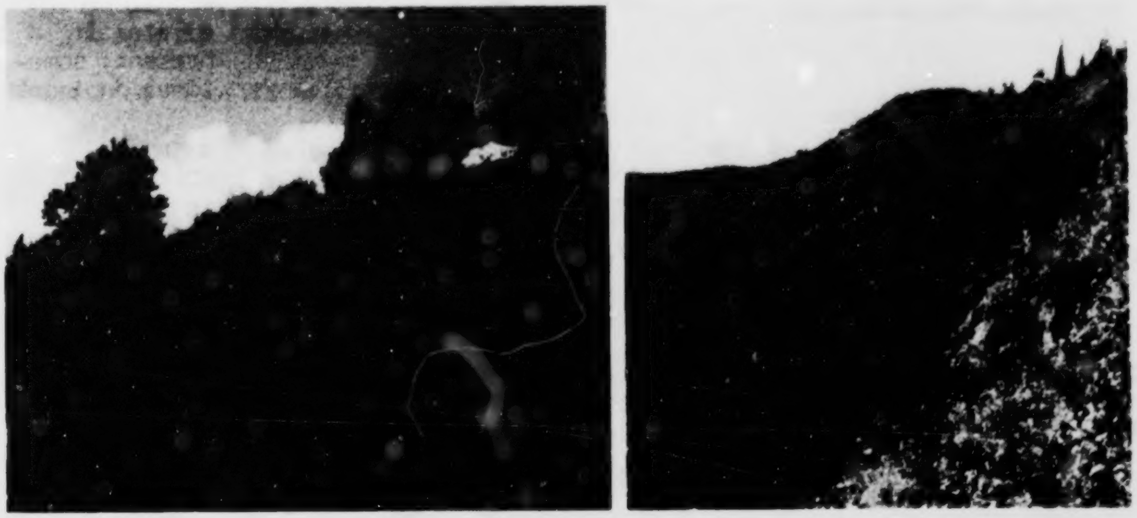
The moss layer is moderately well-developed. *Pleurozium schreberi* is the constant dominant species, but the lichens *Cladina rangiferina* and *C. mitis* are common as well. Other typical species include *Dicranum polysetum*, *Peltigera aphthosa*, and several different *Cladonia* spp.

Coarse textured, skeletal Orthic Dystric Brunisols develop on fluvialglacial terraces. A weakly structured, reddish to dark yellowish brown Bm supports most of the root growth in the mineral soil under a thin Xeromor. Together, the Bm and Xeromor provide much of the capacity for water and nutrient storage and conservation. The pH of the organic horizons averages 3.8; that of the mineral rooting zone averages 5.2.

SBSd/04 SASKATOON - WHEATGRASS SCRUB/STEPPE

BIOGEOCLIMATIC UNIT: SBSd

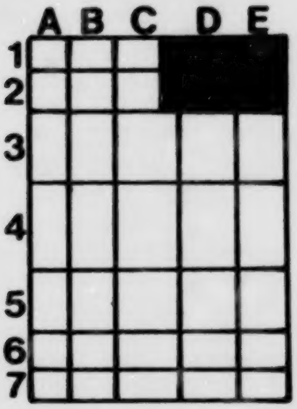
ECOSYSTEM UNIT: SBSd/04; (*Juniperus scopulorum*) - *Amelanchier alnifolia* - *Symphoricarpos albus* - *Agropyron trachycaulum*; Saskatoon - wheatgrass scrub/steppe.



ECOLOGICAL MOISTURE REGIME: Xeric - subxeric

ECOLOGICAL NUTRIENT REGIME: Permesotrophic - eutrophic

DISTRIBUTION: Scattered throughout the major valleys of the subzone on favourable aspects and terrain, but in small patches.



	A	B	C	D	E
1				■	■
2				■	■
3					
4					
5					
6					
7					

PHYSIOGRAPHIC FEATURES:

Slope Positions: Middle and upper; along bedrock outcrops and ridges, or lower morainal slopes beneath calcareous bedrock exposures.

Slope Range: 25 to 80% (usually greater than 60%)

Aspect: South, southwest

Surface Shape: Convex

STRATA COVERAGE (%):	A: 0	B: 46	C: 82	D: 15
GROUND COVERAGE (%):	H: 86	MS: 6	DW: 1	R&S: 7

SBSd/04 SASKATOON - WHEATGRASS SCRUB/STEPPE

VEGETATION:

Shrub Layer: usually well-developed and diverse, although not vigourous.

Amelanchier alnifolia	(Saskatoon)	) -characteristic
Symphoricarpos albus	(snowberry)	) dominants
Juniperus scopulorum	(Rocky Mountain juniper)	-excellent indicator if present; sometimes dominant
Prunus virginiana	(chokecherry)	
Rosa acicularis	(prickly rose)	
[Populus tremuloides	(trembling aspen)]	-poor vigour
[Ribes oxyacanthoides	(cream-flowered gooseberry)]	

Herb Layer: well-developed and very diverse; codominated by grasses and forbs.

Phleum pratense	(timothy)	-introduced species
Agropyron trachycaulum	(slender wheat grass)	
Galium boreale	(northern bedstraw)	
Poa interior	(inland blue grass)	
Stipa richardsonii	(spreading needle grass)	
Lathyrus nevadensis	(purple peavine)	-poor vigour
[Aster conspicuus	(showy aster)]	
[Achillea millefolium	(yarrow)]	
[Koeleria macrantha	(June grass)]	
[Bromus carinatus	(California brome)]	
[Stipa occidentalis var. minor	(stiff needle grass)]	
[Allium cernuum	(nodding wild onion)]	
[Anemone multifida	(Pacific anemone)]	
[Descurainia pinnata	(western tansy mustard)]	
[*Taraxacum officinale	(dandelion)]	-introduced species

Comments: the Saskatoon - wheatgrass ecosystem association represents a distinctive but somewhat heterogeneous assemblage of ecosystems in various stages of succession after fire and under different degrees of grazing or browsing pressure. It has the highest diversity of flowering plants of any ecosystem association in the SBSd, and many of its characteristic species are rare or uncommon elsewhere in the subzone.

SBSd/04 SASKATOON - WHEATGRASS SCRUB/STEPPE

SOILS:

General Description: These soils are usually formed in association with calcareous bedrock, often on colluvial veneers over bedrock or, less frequently, morainal deposits at the lower slopes of the same. Organic horizons are found only as seasonal litter, while a black to very dark grayish brown Ah horizon is always present. Bm(k) and Ck horizons often contain spherical carbonate deposits on the underside of coarse fragments. The pedons are well-drained.

Associated Classifications:

Soil: Orthic Melanic, Sombric and Eutric Brunisols (infrequently Dark Gray Luvisols)

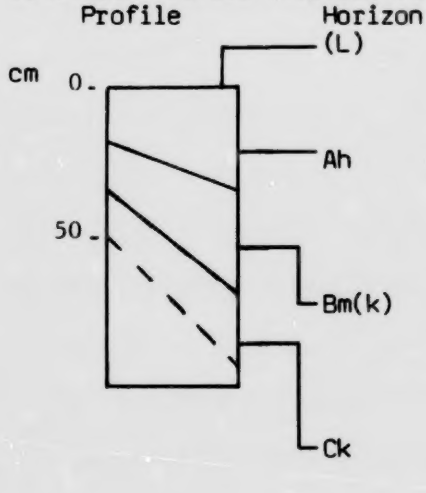
Humus Form: Rhizomull

Terrain: Colluvial veneer over bedrock (morainal veneers over bedrock and morainal blankets)

Parent Materials: Colluvium; less frequently till

Bedrock Geology: Calcareous sedimentary and basic volcanics

Schematic Profile (representing colluvial veneer over bedrock):



Horizon	Description
(L)	-seasonally scattered litter that rapidly decomposes and is incorporated in mineral profile.
Ah	-black to very dark grayish brown; loam to sandy loam; often skeletal; fine granular to subangular blocky; abundant fine roots.
Bm(k)	-dark brown; loam to sandy loam; often skeletal; single grain; plentiful roots; (carbonates on bottom of coarse fragments).
Ck	-brown; sandy loam; few roots, carbonates on bottom of coarse fragments; over calcareous meta-sedimentary or basic volcanic bedrock.

Key Characteristics:
- generally shallow colluvium over calcareous bedrock
- dark Ah horizon
- carbonates on bottom of coarse fragments in subsurface horizons

Comments: This association may occur on finer textured morainal deposits, but usually at lower slopes of calcareous bedrock exposures.

SBSd/04 SASKATOON - WHEATGRASS SCRUB/STEPPE

Dry rocky ridges and bedrock outcrops in the SBSd usually have some sort of seral or fire-climax vegetation dominated by lodgepole pine, trembling aspen and willows (Salix spp.). Most such habitats belong to the SBSd/02 or /03. However, when a dry rocky site with a favourable warm aspect occurs over calcium-rich parent materials derived from sedimentary and basic volcanic bedrock, the result in the SBSd often is the Saskatoon - wheatgrass ecosystem association. The e.a. may also occur on morainal veneers over lower slopes below such outcrops.

The SBSd/04 is usually represented by a mosaic of 'scrub' and 'steppe' (grassland). The habitat is generally too dry for fullgrown trees, although scattered hybrid white spruce sometimes occur. Often this e.a. takes the form of a 'savanna' or savanna/scrub, with scattered tall shrubs/small trees of Rocky Mountain juniper or sometimes aspen in a matrix of herbaceous or shrubby vegetation.

The shrub layer is usually well-developed and diverse, although the vigour of most species is reduced from that evident in adjacent moister ecosystems. Amelanchier alnifolia and Symphoricarpos albus are characteristic dominants. Prunus virginiana and Rosa acicularis are also very common. Rocky mountain juniper does not always occur, but is sometimes dominant and of fair vigour; if present it is an excellent indicator of this ecosystem association. *Ribes oxyacanthoides* and stunted aspen are also frequent.

Grasses and 'forbs' codominate the well-developed and very diverse herb layer. Typical grasses include the introduced forage species *Phleum pratense* as well as native species such as *Agropyron trachycaulum*, *Poa interior*, *Stipa richardsonii*, *S. occidentalis* var. *minor*, *Koeleria macrantha*, and *Bromus carinatus*. Common forbs include *Galium boreale*, *Lathyrus nevadensis*, *Aster conspicuus*, *Achillea millefolium*, *Allium cernuum*, *Anemone multifida*, and *Descurainia pinnata*, and the introduced *Taraxacum officinale*. Many other herbs may occur in these ecosystems, and often are rare or uncommon elsewhere in the SBS.

The moss layer is poorly developed to almost absent. *Tortula ruralis* is the most characteristic species.

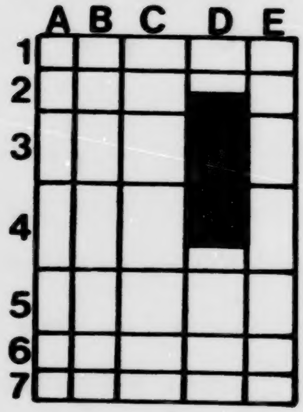
Soils are Orthic Melanic, Sombric, and Eutric Brunisols on colluvial deposits or Dark Gray Luvisols on morainal deposits. All profiles show Ah development, with fine granular to subangular-blocky structure and abundant fine roots. This is the Rhizomull humus form that is always found in these ecosystems. There are no organic soil horizons (F or H) except for a seasonally present litter (L) horizon that rapidly decomposes and becomes incorporated as humus in the Ah.

Subsurface horizons Bm(k) and Ck have spherical carbonate deposits on the underside of coarse fragments. These horizons overlie the bedrock that is usually highly fractured and within one meter of the surface. The pH of the litter was 6.2; that of the mineral rooting zone was 6.0.

SBSd/05 GRASSLAND

BIOGEOCLIMATIC UNIT: SBSd

ECOSYSTEM UNIT: SBSd/05; *Poa* (*pratensis*, *gracillima*, *interior*) - *Stipa richardsonii* - *Agropyron trachycaulum* - *Bromus* (*carinatus*, *anomalus*); Grassland ecosystems.



ECOLOGICAL MOISTURE REGIME: Submesic - mesic

ECOLOGICAL NUTRIENT REGIME: Permesotrophic

DISTRIBUTION: Undisturbed natural grasslands are rare and local in the study area. Evidently native grasslands were originally fairly common though of limited extent in the subzone, but most have long since been converted to hay pastures.

PHYSIOGRAPHIC FEATURES:
Slope Positions: Upper, level.
Slope Range: 0 to 35%
Surface Shape: Straight, slightly concave or convex.

Aspect: Usually southern or western

STRATA COVERAGE (%):	A: 0	B: 2	C: 99	D: 2
GROUND COVERAGE (%):	H: 99	MS: trace	DW: 0	R&S: 0

SBSd/05 GRASSLAND

VEGETATION:

Herb Layer: very well-developed, diverse.

Poa pratensis	(Kentucky blue grass)	
Poa gracillima and/or *P. interior*	(Pacific and/or inland blue grass)	
Agropyron trachycaulum	(slender wheat grass)	
Stipa richardsonii	(spreading needle grass)	
Taraxacum officinale	(dandelion)	-introduced species -poor vigour
Lathyrus nevadensis	(purple peavine)	
Schizachne purpurascens	(false melic)	
[*Fragaria virginiana*	(strawberry)]	
[*Epilobium angustifolium*	(fireweed)]	
[*Elymus glaucus*	(blue wild-rye)]	
[*Bromus carinatus*	(California brome)]	
[*Bromus anomalus*	(nodding brome)]	
[*Carex macloviana*	(thick-headed sedge)]	
[*Danthonia californica*	(California oatgrass)]	

Moss Layer: very sparse or lacking.

Comments: natural grassland is rare and local in the Sub-Boreal Spruce Zone. What little there is has usually been grazed by domestic livestock, with resultant changes in species composition and abundance. We have therefore done little sampling of true grassland ecosystems, and include this brief description here mainly for academic and historical interest.

SBSd/05 GRASSLAND

SOILS:

General Description: The soils have not been studied sufficiently to discuss many characteristics in detail. However, from our limited data and general knowledge of grasslands, we can assume that Ah development is the key feature in profile development. Plant residues decompose and are incorporated into the mineral soil rapidly. These grasslands would have developed on morainal blankets and lacustrine sediments for the most part. Our sampling has described pedons that are fine textured and moderately well-drained.

Associated Classifications:

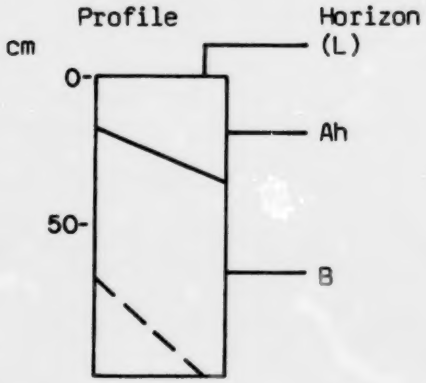
Soil: Dark Gray Luvisols and Orthic Melanic Brunisols

Terrain: Morainal or lacustrine blankets

Humus Form: Rhizomulls

Parent Materials: Glacial till and lacustrine sediments

Schematic Profile:



Description

-thin, loose, discontinuous herbaceous residues.

-black to dark brownish gray; loam or finer; granular to subangular blocky; abundant fine roots.

-subsurface horizons that show some alteration in terms of brunisolic (Bm) or luvisolic (Bt) genetic development.

Comments: Some of these soils satisfy criteria for the Chernozemic Order except that they may lack a soil moisture subclass drier than humid (for which there are no supporting data).

SBSd/05 GRASSLAND

The climate of the Sub-Boreal Spruce Zone is generally too moist for the development of natural grassland. Under certain unusual or azonal conditions of topography and soil, and most probably also as a consequence of recurrent wildfire, grasslands occur. Undisturbed natural grasslands are rare and local in the SBSd. There is, however, some historical evidence that native grasslands were originally fairly common though of limited extent in the subzone, and most have long since been converted to hay pastures. What little grassland remains has mostly been grazed by domestic livestock, with resultant changes in species composition and abundance.

We have not sampled many true grassland ecosystems, but they seem to be of two general types:

1. drier, xeric to subxeric grasslands on steep upper slopes with shallow rocky soils;
2. submesic to mesic grasslands on more moderate slopes with deeper soils.

The dry grasslands are usually small in extent and occur in mosaic with scrub; thus we have grouped them with scrub in the Saskatoon - wheatgrass scrub/steppe e.a. The second type of grassland probably originally covered fairly extensive areas of favourable south and southwestern till slopes in the main Bulkley Valley and also in the Ootsa Lake country. Vestiges of these grasslands still remain around Cheslatta Lake and Chelaslie Arm of Natalkuz Lake.

The herb layer is very well-developed and diverse. Dominant grasses are *Poa pratensis*, *P. gracillima*, *P. interior*, *Agropyron trachycaulum*, and sometimes *Stipa richardsonii*. *Koeleria macrantha*, *Elymus glaucus*, *Schizachne purpurascens*, *Bromus carinatus*, *B. anomalus*, and *Danthonia californica* are also common. *Carex macloviana* is a frequent sedge. Typical forbs include *Lathyrus nevadensis*, *Epilobium angustifolium*, *Fragaria virginiana*, *Taraxacum officinale*, and *Achillea millefolium*.

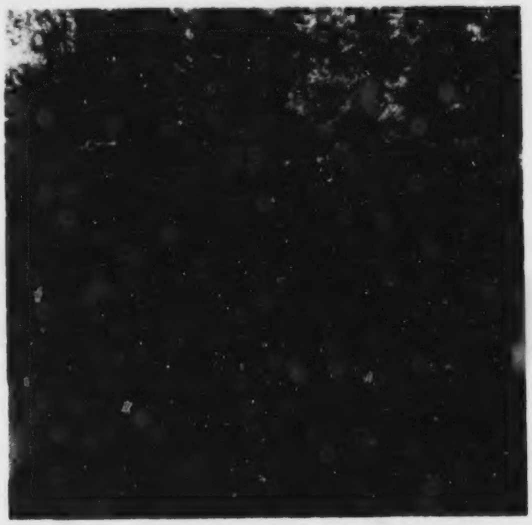
The moss layer is very sparse or lacking.

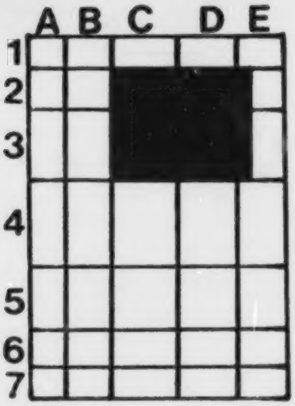
Ah development is the dominant feature of these soil profiles, as it is in all grasslands. Our research plots described the soils as Orthic Melanic Brunisols and Dark Gray Luvisols, with a Rhizomull humus form as in the SBSd/04. We assume that these grasslands developed on and were limited to morainal and lacustrine blankets. The soils are finer textured and moderately well-drained. Some of these soils satisfy criteria for the Chernozemic Order except that they may lack a soil moisture subclass drier than humid (there are no data to decide one way or the other). A litter (L) horizon made up of loose and discontinuous herbaceous residues may be seasonally present. The litter had a pH value of 5.4 while the pH of the mineral rooting zone was 5.9.

SBSd/06 DOUGLAS-FIR - SOOPOLALLIE

BIOGEOCLIMATIC UNIT: SBSd

ECOSYSTEM UNIT: SBSd/06; *Pseudotsuga menziesii* - (*Picea glauca* x *engelmannii*) - *Shepherdia canadensis*; Douglas-fir - soopolallie ecosystem association.





ECOLOGICAL MOISTURE REGIME: Submesic - subxeric

ECOLOGICAL NUTRIENT REGIME: Mesotrophic - subeutrophic

DISTRIBUTION: Uncommon and local in the study area, occurring primarily around the eastern ends of Babine and Francois lakes.

PHYSIOGRAPHIC FEATURES:
Slope Positions: Variable; middle, upper, crest; usually on or near bedrock outcrops and ridges.
Slope Range: 0 to 65%
Surface Shape: Straight to convex.
Aspect: Variable; southerly more often than not.

STRATA COVERAGE (%): A: 46 B: 40 C: 17 D: 45

GROUND COVERAGE (%): H: 86 MS: 3 DW: 10 R&S: 1

SBSd/06 DOUGLAS-FIR - SOOPOLALLIE

VEGETATION:

Tree Layer: canopy fairly open; trees widely spaced; stands sometimes with Douglas-fir veterans.
Pseudotsuga menziesii (Douglas-fir)
[*Picea glauca* x *engelmannii* (hybrid white spruce)]

Shrub Layer: poorly to moderately developed.
P. menziesii)-regeneration
[*P. glauca* x *engelmannii*])
[*Abies lasiocarpa* (subalpine fir)])
Shepherdia canadensis (soopolallie) -characteristic dominant

[*Spiraea betulifolia* (birch-leaved spirea)]
[*Rosa acicularis* (prickly rose)]

Herb Layer: sparse to poorly developed.
[*Elymus glaucus* (blue wild-rye)]
[*Linnaea borealis* (twinflower)]

Moss Layer: moderately developed, sometimes with frequent lichens.
Pleurozium schreberi (red-stemmed feather moss)
[*Hylocomium splendens* (stepped feather moss)]
[*Peltigera aphthosa*]
[*Cladonia* spp.]

Comments: a rare but distinctive ecosystem association in the study area.

SBSd/06 DOUGLAS-FIR - SOOPOLALLIE

SOILS:

General Description: Soils in this ecosystem association have developed from colluvium or till, often skeletal. Soils derived from till often show luvisolic development (Bt) and soils derived from colluvium or till have Bm horizons at or close to the surface. A moderately decomposed F horizon, slightly friable to matted, comprises the bulk of the organic horizons, while a H horizon may be present and commonly contains appreciable amounts of charcoal. The pedons are moderately well to rapidly drained.

Associated Classifications:

Soil: Orthic Dystric and Eutric Brunisols, Brunisolic Gray Luvisol

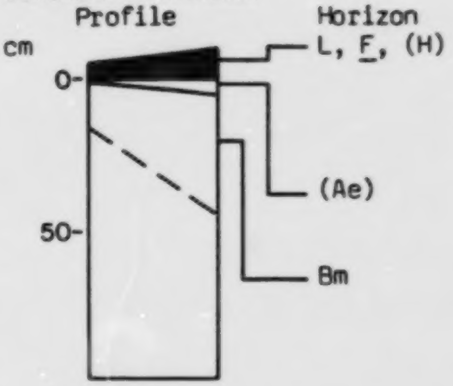
Humus Form: Hemimor

Terrain: Colluvial veneer and and blanket, morainal blanket

Parent Materials: Colluvium and till

Bedrock Geology: May be associated with basic volcanics

Schematic Profile:



Description

-discontinuous coniferous litter mixed with bryophytes over a moderately decomposed F with fungal mycelia common. A thin H horizon may be present.

-gray; loamy; single grain; plentiful roots.

-very dark grayish brown to brown; texture highly variable; plentiful roots over a Bt (in tills) or very slightly altered C horizons and bedrock.

Comments: Requires further sampling.

SBSd/06 DOUGLAS-FIR - SOOPOLALLIE

The interior variety of Douglas-fir (Pseudotsuga menziesii var. glauca) reaches the northwestern limits of its range in the Sub-Boreal Zone of the Prince Rupert Forest Region. Douglas-fir enters the easternmost portion of the study area where it occurs sporadically, but most commonly along the eastern ends of Babine and Francois lakes. The species usually occupies relatively dry, warm, and nutritionally rich habitats on residual soils over bedrock, or on morainal blankets. On such sites Douglas-fir dominates the subxeric to submesic, mesotrophic to subeutrophic Douglas-fir - soopolallie ecosystem association.

Mature stands of the SBSd/06 are made up of widely spaced trees that form a fairly open canopy. Douglas-fir dominates, sometimes as veteran survivors of past fires. Hybrid white spruce is a common associate, while trembling aspen, paper birch, and subalpine fir may also occur. Tree growth is generally poor to fair but Douglas-fir, even under suboptimal conditions at the limit of its range, grows reasonably well and outperforms all other species.

The shrub layer is poorly to moderately developed, depending on stand age and degree of canopy closure. Douglas-fir regeneration is fairly common, while seedlings and saplings of spruce and subalpine fir are uncommon. Shepherdia canadensis is the characteristic dominant shrub; Spiraea betulifolia, Rosa acicularis, and Amelanchier alnifolia are fairly frequent associates.

No species stand out as particularly characteristic of the sparse to poorly developed herb layer. Linnaea borealis, Aster conspicuus, Fragaria *virginiana*, *Galium boreale*, and *Disporum trachycarpum* are the most frequent herbs. Sometimes grasses are abundant and may include *Elymus glaucus*, *Festuca occidentalis*, *Poa pratensis*, and *P. interior*.

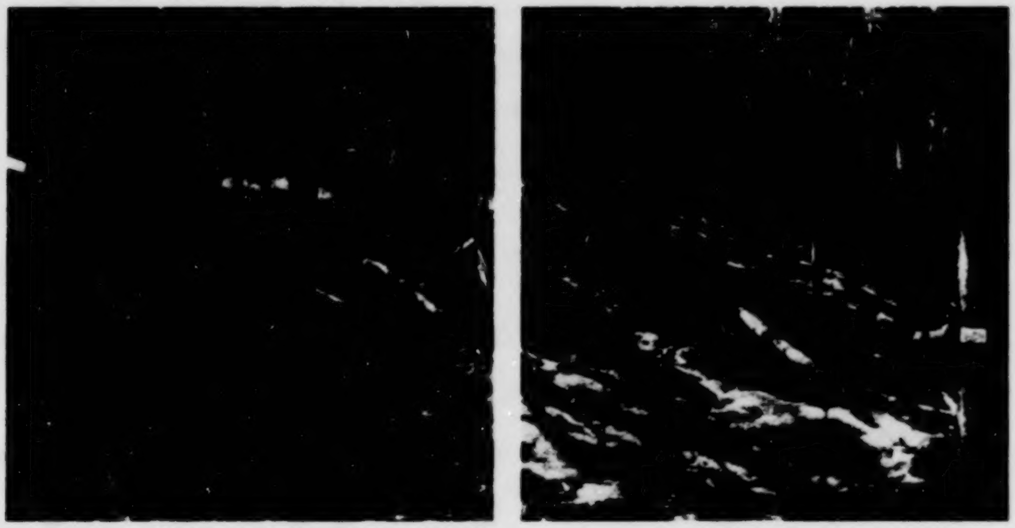
Pleurozium schreberi typifies the moderately developed moss layer. *Hylocomium splendens* and *Peltigera aphthosa* are common associates. Various species of *Cladonia* lichens also frequently occur.

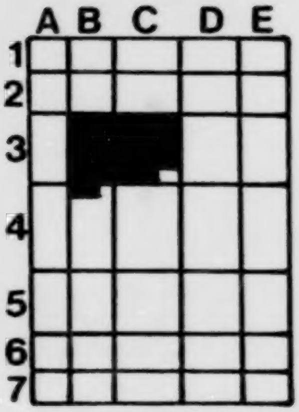
SBSd/06 soils commonly have a very dark, grayish brown to brown Bm horizon with plentiful roots under a Hemimor humus form; however, a thin gray Ae horizon may also be present. In tills, a Bt horizon may occur under the Bm. The soils have been classified as Orthic Dystric and Eutric Brunisols and Brunisolic Gray Luvisols. Basic volcanic bedrock has been associated with the shallow, lithic profiles. A fungal, moderately decomposed F horizon dominates the organic soil horizons and charcoal is often common. Thin L and H horizons may be present. The pH averages 4.5 in the organic horizon and 5.5 in the mineral rooting zone.

SBSd/07 SUBMESIC BUNCHBERRY - MOSS

BIOGEOCLIMATIC UNIT: SBSd

ECOSYSTEM UNIT: SBSd/07; *Pinus contorta* - *Picea glauca* x *engelmannii* - *Rosa acicularis* - *Cornus canadensis* - *Pleurozium schreberi*; Submesic bunchberry - moss ecosystem association.





ECOLOGICAL MOISTURE REGIME: Submesic

ECOLOGICAL NUTRIENT REGIME: Submesotrophic - mesotrophic

DISTRIBUTION: Scattered throughout, but widespread only in the southern part of the subzone (southern Lakes T.S.A.).

PHYSIOGRAPHIC FEATURES:
Slope Positions: All
Slope Range: 0 to 40%
Surface Shape: Straight, convex, slightly concave.

Aspect: All

STRATA COVERAGE (%): A: 53 B: 28 C: 41 D: 86

GROUND COVERAGE (%): H: 91 MS: 0 DW: 9 R&S: 0

SBSd/07 SUBMESIC BUNCHBERRY - MOSS

VEGETATION:

Tree Layer:

Picea glauca x engelmannii	(hybrid white spruce)	
*Pinus contorta	(lodgepole pine)	-fairly good growth
[*Populus tremuloides	(trembling aspen)]	
[*Pseudotsuga menziesii	(Douglas-fir)]	

Shrub Layer: poorly developed; few species.

P. glauca x engelmannii		)	-regeneration
[*P. contorta]		)	
Rosa acicularis	(prickly rose)	)	-characteristic species, but with only poor to fair vigour
Spiraea betulifolia	(birch-leaved spirea)	)	
[Shepherdia canadensis	(soopolallie)]		
[*Alnus viridis	(Sitka or green alder)]		

Herb Layer: moderately developed; vigour merely poor to fair, usually.

Cornus canadensis	(bunchberry)	-characteristic dominant
Linnaea borealis	(twinflower)	
Arnica cordifolia	(heartleaved arnica)	
[Vaccinium caespitosum	(dwarf blueberry)]	
[Orthilia secunda	(one-sided wintergreen)]	
[Epilobium angustifolium	(fireweed)]	
[Geocaulon lividum	(bastard toadflax)]	
[Aster conspicuus	(showy aster)]	

Moss Layer: very well-developed; a feather moss carpet.

Pleurozium schreberi	(red-stemmed feather moss)	-usually dominant
Hylocomium splendens	(stepped feather moss)	
Ptilium crista-castrensis	(knight's plume feather moss)	
[Peltigera aphthosa]		
[Dicranum polysetum]		

Comments: the vegetation of the SBSd/07 or Submesic bunchberry - moss is quite similar to that of the SBSd/01 or Mesic rose - peavine - moss. Note that the two ecosystem associations share many species; the differences between e.a.'s lie in the relative abundance and vigour of these species. Generally, tree growth is slightly poorer, shrub and herb layers less developed and vigourous, and the moss layer better developed and/or more evident in the Submesic bunchberry - moss e.a.

SBSd/07 SUBMESIC BUNCHBERRY - MOSS

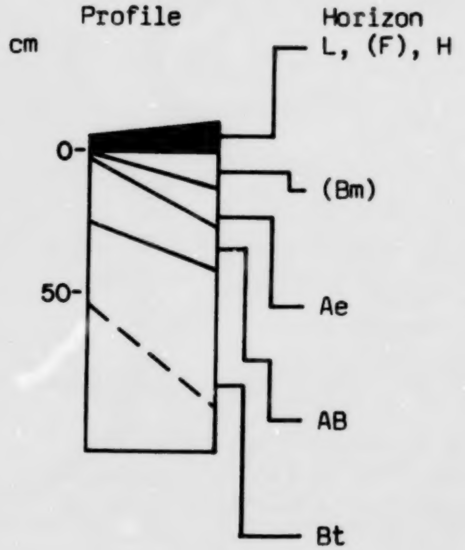
SOILS:

General Description: This association develops on both morainal and fluvialglacial landforms. The tills have root-restricting, fine textured subsurface horizons, and have been classified as either Luvisols or Brunisols. The soils on fluvialglacial landforms are Brunisols. The pedons are moderately well to rapidly drained. The organic horizons average less than 10 cm thick, dominated by a moderately decomposed F with fungal mycelia common. If a H horizon is present, it usually contains appreciable charcoal at the mineral interface.

Associated Classifications:

Soil: Orthic and Eluviated Dystric Brunisols, Orthic and Brunisolic Gray Luvisols	Terrain: Morainal and fluvial-glacial blankets
Humus Form: Hemimor	Parent Materials: Glacial till and fluvial sediments

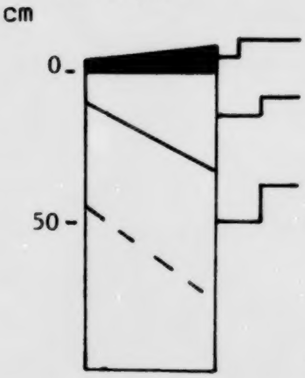
Schematic Profiles:



Horizon	Description
L, (F), H	-thin coniferous litter on a moderately decomposed, slightly compact-matted F horizon with fungal mycelia common. A charcoal-rich H horizon may be present.
(Bm)	-brown to dark brown; loamy; weak sub-angular blocky; plentiful to abundant roots.
Ae	-grayish brown to light grayish brown; sandy loam to loamy sand; weak subangular blocky; plentiful roots.
AB	-light brownish gray; loam to sandy loam; moderate subangular blocky; few to plentiful roots.
Bt	-dark brown to grayish brown; loam to clay loam; subangular blocky to massive; few to very few roots; clay skins on peds and/or over a BC or C horizon; morainal.

Schematic Profiles (continued):

Profile



Horizon	Description
(L), F, (H)	-same as first profile.
Bm	-brown; loam to sandy loam; weak subangular blocky; plentiful roots.
BC	-grayish brown; sandy loam; weak subangular blocky; few roots; over a C or series of C horizons; morainal or glacial-fluvial.

Comments: This association could be phased on soil properties. However, present management interpretations and subsequent silvicultural prescriptions do not require such refinement in classification.

SBSd/07 SUBMESIC BUNCHBERRY - MOSS

The Submesic bunchberry - moss ecosystem association occupies habitats with submesic moisture conditions and submesotrophic to mesotrophic nutrient status. It usually occurs on moderately well to rapidly drained fluvioglacial landforms, or on sloping morainal deposits. Submesic ecosystems are scattered throughout the SBSd, but are widespread only in the southern part of the subzone (southern Lakes T.S.A.).

The distinction between the Submesic and Mesic ecosystem associations is often not sharp, but relative tree growth is a fairly reliable criterion. Submesic stands usually are more open and have poorer growth than mesic stands, and thus reflect the suboptimal growing conditions. Lodgepole pine and hybrid white spruce are the dominant trees. Spruce increases in importance with stand age, but usually does not grow nearly as well as pine. Trembling aspen and Douglas-fir may also occur.

The shrub layer typically is poorly developed and has few species. Spruce regeneration is fairly common, pine much less so. *Rosa acicularis* and *Spiraea betulifolia* are the characteristic species, but they usually are not very vigourous. *Shepherdia canadensis* and *Alnus viridis* are also common.

Cornus canadensis is the characteristic dominant of the moderately developed herb layer. *Linnaea borealis* and *Arnica cordifolia* are frequent associates. Other common but not abundant herbs include *Vaccinium caespitosum*, *Orthilia secunda*, *Geocaulon lividum*, *Epilobium angustifolium*, and *Aster conspicuus*. Note that most of these species are also typical of the Mesic ecosystem association, but in the Submesic e.a. their abundance and vigour are reduced.

The moss layer consists of a very well-developed feather moss carpet. *Pleurozium schreberi* is dominant, but there usually are significant amounts of *Hylocomium splendens* and *Ptilium crista-castrensis*. *Dicranum polysetum* and *Peltigera aphthosa* are also common.

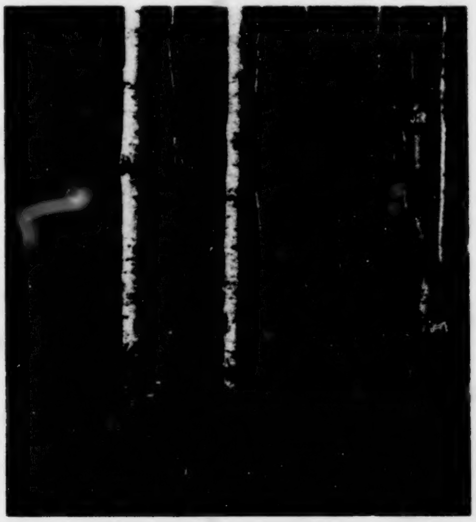
The fluvialglacial soils of the SBSd/07 are Orthic and Eluviated Dystric Brunisols; the soils developed on morainal tills are Orthic or Brunisolic Gray Luvisols, with the Bt horizon often being root-restricting. The organic horizons average less than 10 cm thick and are dominated by a moderately decomposed, fungal F horizon. If a H horizon is present, it usually contains appreciable charcoal at the mineral interface. The humus form is a Hemimor. The pH of the organic horizons averaged 4.8, while the mineral pH in the rooting zone was 4.9.

This ecosystem association could easily be phased based on soil properties. However, present management interpretations and subsequent silvicultural prescriptions do not require such refinement in classification.

SBSd/08 MOIST SHRUB - FORB

BIOGEOCLIMATIC UNIT: SBSd

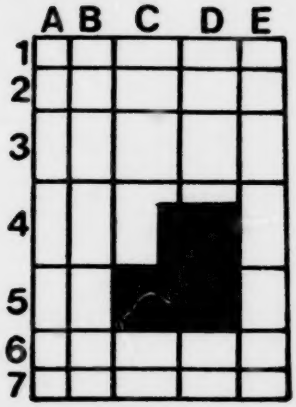
ECOSYSTEM UNIT: SBSd/08; *Picea glauca* x *engelmannii* - *Pinus contorta* - (*Populus tremuloides*) - *Rosa acicularis* - *Viburnum edule* - *Lathyrus nevadensis*; Moist shrub - forb ecosystem association.



ECOLOGICAL MOISTURE REGIME: Mesic - subhygric

ECOLOGICAL NUTRIENT REGIME: Mesotrophic - permesotrophic

DISTRIBUTION: Common and often abundant; more abundant in the northern parts of the subzone.



PHYSIOGRAPHIC FEATURES:
Slope Positions: Middle and lower, or upper if gentle slope.
Slope Range: 0 to 40%
Aspect: All
Surface Shape: Straight, slightly concave.

STRATA COVERAGE (%): A: 58 B: 53 C: 66 D: 63

GROUND COVERAGE (%): H: 91 MS: 0 DW: 9 R&S: trace

SBSd/08 MOIST SHRUB - FORB

VEGETATION:

Tree Layer: stands typically fairly open and partly deciduous; trees relatively widely spaced, but all species have very good growth.

Picea glauca x engelmannii	(hybrid white spruce)
*Pinus contorta	(lodgepole pine)
[*Populus tremuloides	(trembling aspen)]
[*Betula papyrifera	(paper birch)]

Shrub Layer: well-developed; vigourous and diverse; of both tall and low shrubs.

P. glauca x engelmannii	-regeneration	
Rosa acicularis	(prickly rose)	
Viburnum edule	(highbush-cranberry)	) -characteristic dominant
Lonicera involucrata	(black twinberry)	
[Ribes lacustre	(black gooseberry)]	)
[Rubus parviflorus	(thimbleberry)]	)
[*Cornus sericea	(red-osier dogwood)]	) -good indicators if present
[*Symphoricarpos albus	(snowberry)]	)
[*Spiraea douglasii	(hardhack)]	)
[*Salix bebbiana	(Bebb's willow)]	
[*Amelanchier alnifolia	(Saskatoon)]	

Herb Layer: well-developed; vigourous and diverse.

Lathyrus nevadensis	(purple peavine)	)
[+/- L. ochroleucus	(creamy peavine)]	) -characteristic dominants
*Epilobium angustifolium	(fireweed)	)
Rubus pubescens	(trailing raspberry)	)
Cornus canadensis	(bunchberry)	) -frequent and vigourous, but not good indicators
Linnaea borealis	(twinflower)	)
[Galium boreale	(northern bedstraw)]	
[Arnica cordifolia	(heartleaved arnica)]	
[Aster conspicuus	(showy aster)]	
[*Calamagrostis canadensis	(bluejoint)]	-good indicator if present
[Pyrola asarifolia	(pink wintergreen)]	
[Smilacina racemosa	(false Solomon's-seal)]	-good indicator if present
[*Fragaria virginiana	(strawberry)]	
[Petasites palmatus	(palmate colt's-foot)]	
[Osmorhiza chilensis	(sweetcicely)]	) -good indicators if present
[Aralia nudicaulis	(false sarsaparilla)]	)
[Elymus glaucus	(blue wild-rye)]	-frequent but not dominant
[*Heracleum sphondylium	(cow-parsnip)]	-sometimes abundant

SBSd/08 Vegetation page (continued)

Moss Layer: moderately to well-developed, but usually obscured by the dense shrub and herb layers.

Pleurozium schreberi	(red-stemmed feather moss)	) -dominants
Ptilium crista-castrensis	(knight's plume feather moss)	)
Hylocomium splendens	(stepped feather moss)	
[*Rhytidiadelphus triquetrus*]		) -good
[*Brachythecium* spp.]		) indicators,
[*Mnium* spp.]		) but in minor
		quantities

SBSd/08 MOIST SHRUB - FORB

SOILS:

General Description: Fine textured morainal blankets with luvisolic (Bt) development are most generally associated with the SBSd/08. However, Brunisols with fluvial or colluvial parent materials also occur. The F horizon is predominant in the organic layer and may be either friable or matted. Charcoal is found at the mineral interface and in the H horizon (when present). Root restriction is often at the top of the Bt or clay-rich, compacted till. The pedons are usually moderately well-drained and can occur on all slope positions.

Associated Classifications:

Soil: Brunisolic, Orthic, and Gleyed Gray Luvisols; (Orthic Dystric and Eutric Brunisols).

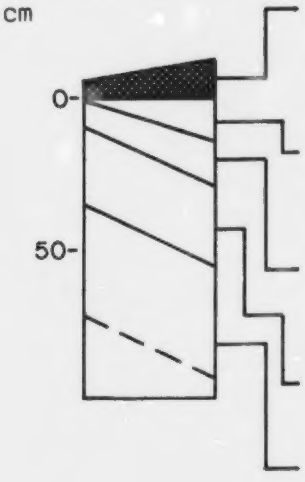
Terrain: Predominantly morainal blankets; less frequently: fluvial, lacustrine, and colluvial blankets

Humus Form: Hemimors, Mormoders

Parent Materials: Variable, but predominantly glacial till

Schematic Profile:*

Profile



Horizon	Description
(L), F, (H)	-loose, discontinuous litter over a friable to slightly compact-matted F horizon. A thin H horizon may be present.
(Bm)	-dark yellowish brown to dark brown; silt loam, loam, or clay loam; granular to subangular blocky; abundant roots.
Ae	-pale brown to yellowish brown; silt loam, loam, or clay loam; platy to sub-angular blocky; plentiful roots.
AB	-similar to Ae but with some clay skins on peds and/or pores.
Bt(g)	-brown to dark yellowish brown; clay loam to clay; (dark yellowish brown mottles); subangular blocky to prism-like; few roots over a BC horizon to till parent materials.

* Brunisolic profile would follow typical (L), F, (H), Bm, BC, C sequence as SBSd/01(a) or /07 (profile 2) with colluvial or fluvial parent materials.

Key Characteristics:
- generally fine textured morainal blankets
- Bt horizons which may be root-restricting and may have mottles
- Brunisolic Gray Luvisols most frequent in the Bulkley watershed, whereas the Orthic subgroup is more frequent in the upper Fraser watershed.

Comments: See report for discussion of physiographic variability.

SBSd/08 MOIST SHRUB - FORB

The Moist shrub - forb ecosystem association develops in habitats that are effectively moister and richer than mesic and mesotrophic. All tree species exhibit very good growth, reflecting the favourable habitat, but mature stands typically are fairly open and partly deciduous. Hybrid white spruce and to a lesser extent lodgepole pine dominate the canopy, but there is often a significant component of trembling aspen and paper birch.

The shrub layer is well-developed and vigourous, and contains both tall and low shrubs. Spruce regeneration is common. Characteristic dominant shrubs are *Rosa acicularis*, *Viburnum edule*, and *Lonicera involucrata*. Other common or sometimes abundant species include *Ribes lacustre*, *Rubus parviflorus*, *Cornus sericea*, *Symphoricarpos albus*, and *Spiraea douglasii*, all of which are fairly good indicators of the habitat. *Salix bebbiana* and *Amelanchier alnifolia* may be frequent, but are not good indicators.

The herb layer is well-developed, vigourous, and typically diverse. *Lathyrus nevadensis* and/or *L. ochroleucus*, *Epilobium angustifolium*, and *Rubus pubescens* are the characteristic dominant species. However, *Cornus canadensis* and *Linnaea borealis* are just as frequent and sometimes as abundant, although these two widespread species indicate the moist rich habitat more by their good vigour than their presence. Among numerous other herbs, additional species with greater than 70% frequency are *Galium boreale*, *Orthilia secunda*, *Arnica cordifolia*, *Aster conspicuus*, *Calamagrostis canadensis*, *Pyrola asarifolia*, *Smilacina racemosa*, *Fragaria virginiana*, *Petasites palmatus*, *Osmorhiza chilensis*, and *Mitella nuda*. *Aralia nudicaulis*, *Elymus glaucus*, and *Heracleum sphondylium* are sometimes abundant.

The dense shrub and herb layers typically obscure the moss layer, which is nevertheless moderately to well-developed. *Pleurozium schreberi* and *Ptilium crista-castrensis* share dominance and are often joined by *Hylocomium splendens*. *Rhytidiadelphus triquetrus* and several species of *Brachythecium* and *Mnium* are good indicators of habitat conditions, but all occur in minor quantities.

The Moist shrub - forb ecosystem association is common and often abundant in the SBSd. It seems to be more widespread in the northern parts of the subzone (Bulkley Valley and vicinity). In the drier southern portions of the subzone (Lakes T.S.A.), the SBSd/08 tends to be more localized in middle to lower slope positions. In its habitat conditions and landscape positions, the Moist shrub - forb ecosystem association is analogous to a combination of the Oak fern and Thimbleberry - forb e.a.'s of the SBSe.

The soils of the Moist shrub - forb e.a. are generally moderately well-drained and can occur on all slope positions. Parent materials are predominantly glacial till; however, this ecosystem association can also be found on fluvial and colluvial deposits.

On the finer textured morainal blankets, Gray Luvisols develop; the Brunisolic subgroup is more common in the Bulkley watershed whereas the Orthic subgroup is more common in the upper Fraser watershed. Orthic Dystric and Eutric Brunisols develop on the coarser fluvial and colluvial landforms.

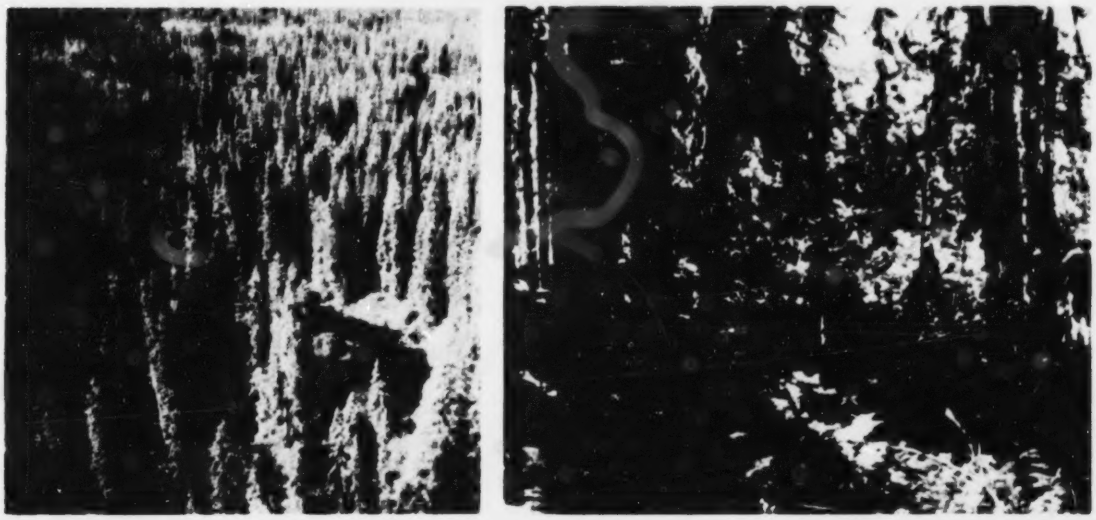
The F horizon dominates the organic horizons and may be either friable or matted. Charcoal is found at the mineral interface and in the sometimes present H horizon. The humus forms may be Hemimors or Mormoders.

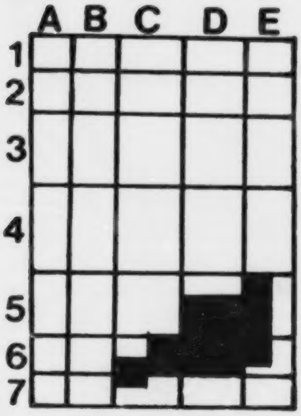
The pH of the organic horizons was 4.7; that of the mineral rooting zone averaged 5.1.

SBSd/09 SPRUCE - HORSETAIL

BIOGEOCLIMATIC UNIT: SBSd

ECOSYSTEM UNIT: SBSd/09; *Picea glauca* x *engelmannii* - *Lonicera involucrata* - *Calamagrostis canadensis* - *Equisetum* (*arvense*, *sylvaticum*); Spruce - horsetail ecosystem association.





ECOLOGICAL MOISTURE REGIME: Subhygric - hygric

ECOLOGICAL NUTRIENT REGIME: Permesotrophic - subeutrophic

DISTRIBUTION: Common throughout the subzone, but rarely abundant.

PHYSIOGRAPHIC FEATURES:
Slope Positions: Lower and toe slopes, and level or depressional sites.

Slope Range: 0 to 7% Aspect: Variable or flat.
Surface Shape: Straight to concave.

STRATA COVERAGE (%): A: 53 B: 56 C: 66 D: 66

GROUND COVERAGE (%): H: 91 MS: 0 DW: 9 R&S: 0

SBSd/09 SPRUCE - HORSETAIL
VEGETATION:

Tree Layer: mature stands with large but widely spaced trees; immature stands often with some deciduous trees.

Picea glauca x engelmannii	(hybrid white spruce)	-good growth
[*Pinus contorta	(lodgepole pine)]	
[*Populus balsamifera ssp. trichocarpa	(black cottonwood)]	
[*Populus tremuloides	(trembling aspen)]	
[*Betula papyrifera	(paper birch)]	

Shrub Layer: moderately to well-developed, with both tall and low shrubs.

P. glauca x engelmannii		-regeneration
Lonicera involucrata	(black twinberry)	-constant dominant
Viburnum edule	(highbush-cranberry)	
Rosa acicularis	(prickly rose)	
Ribes lacustre	(black gooseberry)	
[*Cornus sericea	(red-osier dogwood)]	
[*Alnus incana	(speckled alder)]	

Herb Layer: well-developed, vigourous.

Equisetum arvense	(common horsetail)	) -dominant species in mature stands, individually or in combination
Equisetum pratense	(meadow horsetail)	)
Equisetum sylvaticum	(wood horsetail)	)
Calamagrostis canadensis	(bluejoint)	
[Galium triflorum	(creeping sweet bedstraw)]	
[Rubus pubescens	(trailing raspberry)]	
[Actaea rubra	(baneberry)]	
[*Epilobium angustifolium	(fireweed)]	
[*Lathyrus nevadensis and/or L. ochroleucus	(peavine)]	
[Smilacina racemosa	(false Solomon's-seal)]	
[Mitella nuda	(creeping mitrewort)]	
[Elymus glaucus	(blue wild-rye)]	
[*Aster modestus	(great northern aster)]	
[*Heracleum sphondylium	(cow-parsnip)]	-sometimes abundant

Moss Layer: generally moderately developed but patchy.

Mnium spp.	) -no one species consistently dominates, but in the aggregate these are the most characteristic mosses
[Brachythecium spp.]	)

SBSd/09 Vegetation page (continued)

[*Hylocomium splendens*	(stepped feather moss)]	)-localized on
[*Pleurozium schreberi*	(red-stemmed feather moss)]	)higher micro-
[*Ptilium crista-castrensis*	(knight's plume feather moss)]	)sites; not good indicators
[*Aulacomnium palustre*]		-good indicator if present

Comments: the Spruce - horsetail ecosystem association is often represented by seral stands of aspen and/or cottonwood with a lush understory of shrubs and herbs, most typically *Lonicera involucrata* and *Heracleum sphondylium*.

SBSd/09(a) SPRUCE - HORSETAIL, FLUVIAL PHASE

SOILS:

General Description: This phase occurs on active floodplains and therefore soil development remains youthful. Organic horizons show a trend toward moder development and the mineral profile may have a thin Ah horizon. The mineral horizons are generally well-sorted and coarse textured, with stratified parent materials. The pedons are well-drained and occur on lower and level slope positions.

Associated Classifications:

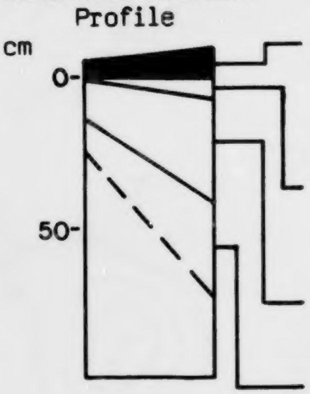
Soil: Orthic Dystric Brunisols

Terrain: Active fluvial blankets

Humus Form: Mormoder

Parent Materials: Stratified fluvial sediments

Schematic Profile:



Horizon	Description
L, (F), H	-very little litter scattered on and in bryophytes over a dominant slightly matted to friable F horizon with abundant roots.
(Ah)	-dark brown; loam to silt loam; granular to subangular blocky; abundant roots.
Bm	-brown to dark brown; coarse textures; plentiful roots.
IIC	-variable colours; coarse textures; few roots; over stratified sediments.

Key Characteristics:
- active fluvial floodplains
- well-drained
- series of sediments (IIC, IIIC, etc.)

SBSd/09(b) SPRUCE - HORSETAIL, LACUSTRINE PHASE

SOILS:

General Description: This phase occurs on poorly drained lacustrine veneers with Hydromoder humus forms over gleysolic soils. Textures in the Ah horizons are fine, while underlying materials can vary considerably in texture. Water tables are present generally within 50 cm of the surface, and seepage can also be present above the water table in the profile.

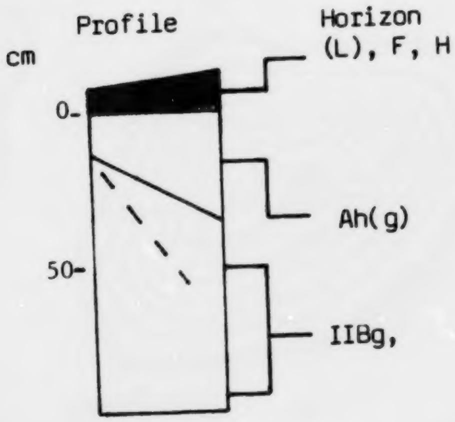
Associated Classifications:
Soil: Rego and Orthic Humic Gleysols

Terrain: Lacustrine veneers over morainal or fluvial blankets

Humus Form: Hydromoders

Parent Materials: Fresh-water mineral sediments over glacial till or fluvial deposits

Schematic Profile:



Description

-loose, structureless litter over a matted, fibric F horizon with fungal mycelia common. The H horizon is matted to granular, greasy, with abundant to plentiful roots.

-black; silt loam to clay; (grayish brown mottles); granular to subangular blocky; few to abundant roots.

-gleyed colours; variable textures and IICg, coarse fragments; structureless; very few to no roots; morainal or fluvial parent materials.

Key Characteristics:
- water table within 50 cm of surface
- Ah horizons with no coarse fragments
- organic horizons poorly aerated, saturated for prolonged periods, generally greater than 10 cm thick.

SBSd/09 SPRUCE - HORSETAIL

Mature stands in the Spruce - horsetail ecosystem association typically are fairly open and dominated by large but widely spaced hybrid white spruce trees. Immature stands often have some lodgepole pine as well as the deciduous species cottonwood, trembling aspen, and paper birch.

The shrub layer is moderately to well-developed and, like that of the Moist shrub - forb e.a., includes vigourous tall and low shrubs. Spruce is the only tree species that regenerates in mature stands. Its seedlings and saplings are scattered and usually occur on higher microsites (such as old root platforms) and decaying logs. *Lonicera involucrata* is the constant dominant shrub. *Ribes lacustre*, *Viburnum edule*, and *Rosa acicularis* are also characteristic species. *Cornus sericea* and *Alnus incana* are common.

The well-developed and vigourous herb layer is dominated (in mature stands) by one or a combination of *Equisetum arvense*, *E. pratense*, and *E. sylvaticum*. *Calamagrostis canadensis* is also characteristic. Other herbs that are common or sometimes abundant include *Galium triflorum*, *Rubus pubescens*, *Actaea rubra*, *Epilobium angustifolium*, *Lathyrus nevadensis* and/or *L. ochroleucus*, *Smilacina racemosa*, *Mitella nuda*, *Elymus glaucus*, *Aster modestus*, and *Heracleum sphondylium*.

The moss layer is generally moderately developed but patchy. Several species of *Mnium* and *Brachythecium* are common and, though no one species consistently dominates, in the aggregate these are the most characteristic mosses. *Aulacomnium palustre* frequently occurs and is a good indicator if present. Feather mosses are also common but localized on higher drier microsites, and are not good indicators of the moist rich habitat.

The SBSd/09 is common throughout the subzone, although it is rarely extensive. Typically this ecosystem association occupies moist to wet, moderately rich habitats that occur on gentle lower and toe slopes, or on level or depressional sites. On lacustrine veneers drainage is usually poor, but the Spruce - horsetail e.a. also develops on moderately well-drained fluvial sites. On older fluvial terraces, the SBSd/09 evidently includes a successional sequence from seral cottonwood to mature spruce forest. However, the flooding cycle on active floodplains seems to be frequent enough to arrest most successions short of the theoretical spruce climax. Thus we have maintained a separate Cottonwood bottomland ecosystem association, the SBSd/10. Also, on burned or otherwise frequently disturbed sites in morainal landscapes, the SBSd/09 is often represented by seral stands of aspen, cottonwood, and sometimes birch, with lush secondary vegetation of shrubs and herbs, most typically Lonicera involucrata and Heracleum sphondylium.

The Spruce - horsetail ecosystem association has two phases, a well-drained fluvial phase and a poorly drained lacustrine phase.

The fluvial phase (SBSd/09(a)) has Orthic Dystric Brunisols on stratified fluvial sediments of active floodplains. The humus form is generally a Mormoder and the mineral profile may have a thin Ah horizon over a brown to dark brown Bm. It is in these horizons that rooting occurs and water and nutrient availability and conservation are concentrated. Underlying these horizons are a series of C horizons (IIC, IIIC, etc.) which reflect the sequential nature of the sedimentation processes that have occurred on these sites.

The average pH value of the organic horizons was 4.8 and in the mineral rooting zone pH averaged 5.1.

The lacustrine phase (SBSd/09(b)) occurs on poorly drained lacustrine veneers over morainal or fluvial blankets. These profiles have a Hydromor humus form over gleysolic soils (Rego and Orthic Humic Gleysols). Textures in the Ah horizons are fine, while textures of underlying materials vary considerably. The average pH was 4.8 both in the organic horizons and in the mineral rooting zone.

SBSd/10 COTTONWOOD BOTTOMLAND

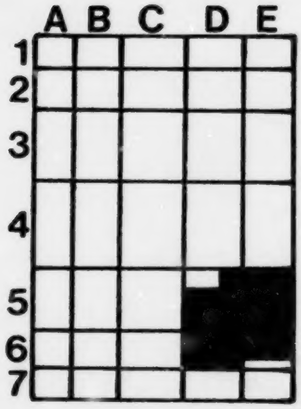
BIOGEOCLIMATIC UNIT: SBSd

ECOSYSTEM UNIT: SBSd/10; Populus balsamifera ssp. trichocarpa - Picea glauca x engelmannii - Cornus sericea - Lonicera involucrata; Cottonwood bottomland ecosystem association.

ECOLOGICAL MOISTURE REGIME: Subhygric - hygric

ECOLOGICAL NUTRIENT REGIME: Permesotrophic - eutrophic

DISTRIBUTION: Localized on the active floodplains of the major rivers within the subzone.



PHYSIOGRAPHIC FEATURES:
Slope Positions: Valley bottoms

Slope Range: 0 (level)

Surface Shape: Straight (flat)

Aspect: Flat

STRATA COVERAGE (%): A: 46 B: 74 C: 39 D: 1

GROUND COVERAGE (%): H: 86 MS: 0 DW: 14 R&S: 0

SBSd/10 COTTONWOOD BOTTOMLAND

VEGETATION:

Tree Layer: in older stands, typically a main canopy of large, widely spaced cottonwood with scattered spruce in the understory.

Populus balsamifera ssp. *trichocarpa*	(black cottonwood)	
[*Picea glauca* x *engelmannii*	(hybrid white spruce)]	-excellent growth

Shrub Layer: very well-developed, vigourous; with both tall and low shrubs.

[*P. glauca* x *engelmannii*]		-regeneration
Cornus sericea	(red-osier dogwood)	) -characteristic
Lonicera involucrata	(black twinberry)	) dominants
Viburnum edule	(highbush-cranberry)	
Rosa acicularis	(prickly rose)	
[*Alnus incana*	(speckled alder)]	) -sometimes
[*Salix* spp.	(willows)]	) small trees
[*Symphoricarpos albus*	(snowberry)]	

Herb Layer: moderately well-developed and diverse; with good vigour but patchy.

Calamagrostis canadensis	(bluejoint)
Vicia americana	(American vetch)
Elymus glaucus	(blue wild-rye)
Osmorhiza chilensis	(sweetcicely)
[*Petasites palmatus*	(palmate colt's-foot)]
[*Smilacina racemosa*	(false Solomon's-seal)]
[*Actaea rubra*	(baneberry)]

Moss Layer: sparse or lacking.

Comments: its distinctive landform and vegetation make the Cottonwood bottomland ecosystem association unmistakable. It occurs in a wide range of seral stages.

SBSd/10 COTTONWOOD BOTTOMLAND

SOILS:

General Description: These soils are developed on active floodplains (often river islands) and are coarse textured and rapidly drained. Organic horizons consist of friable L and F horizons and vary in depth. A Bm horizon may be present over various C horizons of sorted and stratified fluvial sediments. The ecosystems are often channelized and subject to frequent flooding.

Associated Classifications:

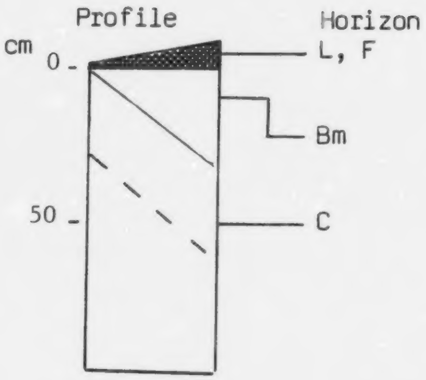
Soil: Orthic Dystric Brunisols, Regosols

Terrain: Active fluvial floodplains (often river islands)

Humus Form: Moders

Parent Materials: Well sorted, stratified fluvial sediments

Schematic Profile:



Description

-various depths (1-10 cm) of loose, friable plant residues.

-dark brown to brown; loam to sandy loam; plentiful roots.

-brownish, but variegated; sandy textures, variable amounts of coarse fragments; few to no roots; over series of stratified sediments (IIC, IIIC, etc.).

Key Characteristics:

- active floodplains, river islands
- rapid drainage
- well-sorted, stratified fluvial sediments

SBSd/10 COTTONWOOD BOTTOMLAND

Rivers and streams in the SBSd with wide meander plains usually are bordered by cottonwood stands on the active floodplains. These floodplain forests, in response to the dynamic nature of the active fluvial landforms, occur in various successional stages. However, mature stands typically have a main canopy of tall, widely spaced but broad-crowned cottonwood, with hybrid white spruce scattered in the understory and sometimes reaching the canopy. Spruce growth is outstanding in these moist and rich but well-drained ecosystems. Unfortunately, there usually are not many spruce and the ecosystem association itself is not widespread.

The shrub layer is very well-developed, vigourous, and often nearly impenetrable. Tall and low broadleaved deciduous shrubs dominate, including Cornus sericea and Lonicera involucrata (the characteristic dominants) as well as Viburnum edule and Rosa acicularis. Symphoricarpos albus, Alnus incana, and Salix spp. are also common; the alder and willows sometimes grow to be small trees. Scattered spruce regeneration is usually all that can be found of conifers in the shrub layer.

The herb layer is moderately well developed, diverse, and vigourous. Its patchiness is largely a response to the uneven density of the tree canopy and shrub layer. Typical species are Calamagrostis canadensis, Vicia americana, Elymus glaucus, and Osmorhiza chilensis. Petasites palmatus, Smilacina racemosa, and Actaea rubra are also common.

The moss layer is sparse or lacking; the forest floor is densely shaded and covered mostly by dead leaves and other litter.

Orthic Dystric Brunisols and Regosolic soils develop on these active floodplains, which are often river islands. The sites are often channelized and, of course, subject to frequent flooding. Soils are coarse textured and rapidly drained. When present, the Bm horizon is dark brown to brown over a series of C horizons that have variegated colours. The organic horizons are friable L and F horizons that constitute a variety of Moder humus forms. The organic horizons' average pH was 5.6; the mineral rooting zone's averaged 5.4.

WETLANDS

Definition

Most people are familiar with the terms 'marsh', 'swamp', and 'bog', but only relatively recently have these well-known landscape units been grouped together under the single term 'wetlands'. We have no single, correct, ecologically sound definition for wetlands, primarily because wetlands are so diverse and because they often pass into uplands by gradual transition.

A functional definition of wetlands stresses that saturation with water is the dominant factor determining the nature of soil development and the type of plant and animal communities living in the soil and on its surface (Cowardin et al. 1979). The common denominator of most wetlands is soil or substrate that is at least periodically saturated with or covered by water. Thus, the National Wetland Working Group of Canada has defined wetlands as "lands having the water table at, near, or above the land surface or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophilic vegetation and various kinds of biological activity which are adapted to the wet environment" (Tarnocai 1980). We have adopted a simpler definition suitable for the Sub-Boreal Spruce Zone from Runka and Lewis (1981):

"Wetlands are lands that are wet enough or inundated frequently enough to develop and support a distinctive natural vegetative cover that is in strong contrast to the adjacent matrix of better drained lands".

Classification

Wetland classes recognized in Canada include shallow open water, marsh, fen, swamp, and bog (Zoltai et al. 1975; Tarnocai 1980).

Shallow Open Water

This wetland class comprises permanent shallow (less than 2m) standing water that lacks extensive emergent plant cover.

Marsh

Marshes are wetlands that are permanently or seasonally inundated with nutrient-rich water, and that support extensive cover of emergent herbaceous vegetation rooting in mineral-rich substrate.

We have not done any studies of open water or marshes. We have, however, sampled a few forested types of fen, swamp, and bog.

Fen

Fens are wetlands comprised of accumulations of well to poorly decomposed non-Sphagnic peats. Most fens have in excess of 40 cm of peat accumulation. Fen waters derive mostly from groundwater, streams, and runoff from adjacent mineral uplands. As a result, fens are less acid and more mineral-rich than are bogs. Fen vegetation may be dominated by sedges, grasses, or low shrubs (sometimes with scattered trees), often underlain by "rich" mosses such as *Tomenthypnum nitens*, *Aulacomnium palustre*, and species of *Drepanocladus* and *Calliergon*. Hummock-forming *Sphagnum* mosses are uncommon or lacking, except in fens that are transitional to bogs. Fen peat is well to moderately decomposed. Associated soils are Mesisols and Humisols.

Swamp

Swamps are wooded wetlands dominated by trees or tall shrubs (25% or greater cover), and characterized by periodic flooding and nearly permanent subsurface water flow through various mixtures of mineral sediments and peat. Swamps are, like fens, rich in minerals and nutrients, but the characteristic water movement through swamps tends to increase the availability of nutrients and oxygen. Swamp waters thus have sufficient levels of dissolved oxygen to support either tall shrubs or trees. Swamp vegetation in the SBS includes forests of white and/or black spruce (sometimes with deciduous trees) and stands of tall *Salix* spp. and *Betula glandulosa*, often with *Alnus incana* and *Spirea douglasii*. The substrate of swamps ranges from mineral material with surface enrichment with organic matter, through mixtures (often interlayered) of mineral and organic materials to organic accumulations of 50 cm or more. The associated soils are Mesisols, Humisols, and Gleysols.

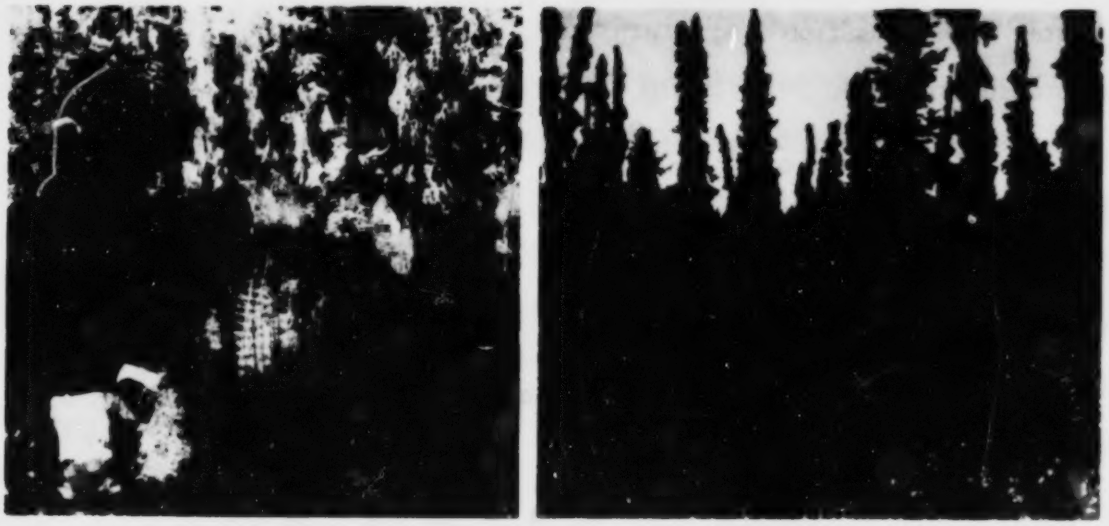
Bog

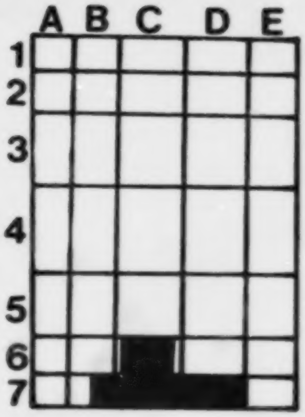
Bogs are wetlands covered or filled with poorly to moderately decomposed Sphagnum-derived peats. Bog surfaces are often raised, or level with their immediate surroundings, and thus are little affected by nutrient-rich groundwater from the surrounding mineral soils. Precipitation, a relatively poor source of dissolved ions, is the major source of water in the upper peat. Hence, the upper peat layer of bogs is strongly acid and low in nutrients. Bog vegetation in the Sub-Boreal Spruce zone is characterized by a dominant moss cover of Sphagnum mosses with variable amounts of low 'ericaceous' shrubs, black spruce trees, sedges (Carex spp.), and cottongrass (Eriophorum spp.), and lichens. Peat materials in bogs derive primarily from Sphagnum moss and forest materials (decaying wood and litter); the typical bog peat is sometimes underlain by more decomposed fen peat. Bog soils in the SBSd are usually Fibrisols, Mesisols, or Humisols.

SBSd/11 SWAMPS

BIOGEOCLIMATIC UNIT: SBSd

ECOSYSTEM UNIT: SBSd/11; Picea (mariana, glauca x engelmannii) - Betula glandulosa - Carex disperma - Tomenthypnum nitens; Swamp ecosystems.





ECOLOGICAL MOISTURE REGIME: Hygric - subhydric

ECOLOGICAL NUTRIENT REGIME: Submesotrophic - permesotrophic

DISTRIBUTION: Scattered throughout the subzone, but nowhere extensive.

PHYSIOGRAPHIC FEATURES:

Slope Positions: Level and depressional moisture-collecting positions.

Slope Range: 0 (level)

Aspect: Not applicable.

Surface Shape: Straight (flat) but often hummocky.

STRATA COVERAGE (%):	A: 30	B: 37	C: 73	D: 75
GROUND COVERAGE (%):	H: 93	MS: 0	DW: 3	R&S: 0

SBSd/11 SWAMPS

VEGETATION:

Tree Layer: trees scattered and clumped, rarely forming a canopy.

Picea mariana	(black spruce)	
Picea glauca x engelmannii	(hybrid white spruce)	-sometimes with fairly good growth

Shrub Layer: moderately to well-developed.

P. mariana		-regeneration and stunted mature individuals
[P. glauca x engelmannii]		-regeneration
Betula glandulosa	(scrub birch)	
[Salix barclayi	(Barclay's willow)]	
[Ledum groenlandicum	(Labrador tea)]	
[Cornus sericea	(red-osier dogwood)]	
[Alnus incana	(speckled alder)]	

Herb Layer: well-developed, dominated by sedges and horsetails.

Carex disperma	(soft-leaved sedge)	-characteristic dominant
Equisetum arvense	(common horsetail)	
and/or E. fluviatile	(swamp horsetail)	
Potentilla palustris	(marsh cinquefoil)	
[Calamagrostis canadensis	(bluejoint)]	
[Carex limosa	(shore sedge)]	
[Vaccinium oxycoccos	(bog cranberry)]	

Moss Layer: well-developed but not continuous.

Tomenthypnum nitens		-good indicator
Sphagnum spp.	(sphagnum or peat moss)	-several species, none exclusively dominant
[Aulacomnium palustre]		
[Hylocomium splendens	(stepped feather moss)]	
[Drepanocladus spp.]		
[Calliergon spp.]		
[Mnium spp.]		

Comments: swamps differ from bogs in having more available nutrients and thus better tree growth, more vigourous shrubs and herbs, less dominance by Sphagnum mosses, and a greater abundance of "rich" mosses such as Tomenthypnum nitens and various Drepanocladus, Calliergon, and Mnium species.

SBSd/11 SWAMPS

SOILS:

General Description: These soils are organic and more than one meter deep. The middle tier (40 - 120 cm) is usually mesic (Om) and may have a fibric (Of) horizon on the surface. The profiles are usually saturated and very poorly drained on level or depressional landscapes.

Associated Classifications:

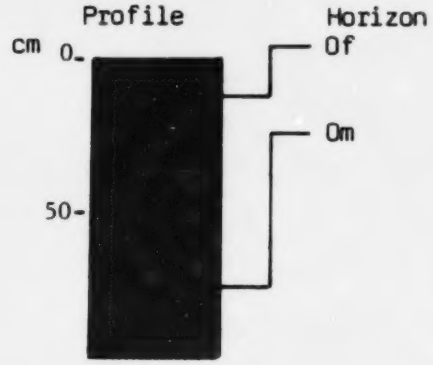
Soil: Mesisols, (Fibrisols)

Terrain: Organic blankets

Humus Form: Histomor, Histomoder

Parent Materials: Plant residues

Schematic Profile:



Description

-plant residues show little evidence of decomposition; erect; few roots.

-plant residues show moderate decomposition; massive; few roots.

Key Characteristics:

- organic blankets, usually mesic horizons in the middle tier.

SBSd/11 SWAMPS

We have sampled several swamp ecosystems in the SBSd. The vegetation of these ecosystems is too variable to group into a single association, but the different types of swamps that may be encountered in the spruce subzone of the SBS are obviously closely related and share several features.

Tree species include black and hybrid white spruce and occasionally cottonwood. The trees usually grow poorly and do not form a closed canopy.

The shrub layer is moderately to well-developed with scattered stunted and regenerating trees, as well as species of willow (*Salix glauca*, *S. bebbiana*, *S. barclayi*, *S. drummondiana*), *Betula glandulosa*, *Alnus incana*, *Cornus sericea*, and *Ledum groenlandicum*. Some swamps in the SBSd are virtually treeless, and dominated by deciduous shrubs such as those mentioned above.

Sedges (particularly *Carex disperma*, *C. aquatilis*, *C. limosa*) dominate the well developed herb layer. Vigourous *Calamagrostis canadensis* is a characteristic grass, and *Potentilla palustris*, *Equisetum arvense*, and *E. fluviatile* are also common herbs.

The very well-developed moss layer often contains some *Sphagnum* (especially *S. capillaceum*) in clumps, but more characteristic are mosses such as *Tomenthypnum nitens*, *Aulacomnium palustre*, *Drepanocladus* spp., *Calliergon* spp. and *Mnium* spp. These latter mosses all indicate the richer, more minerotrophic conditions that characterize swamps (cf. Stanek 1977).

The soils are organic and more than one meter deep. Most soils are Mesisols but Fibrisols are also found. Both Histomor and Histomoder humus forms have been described in these ecosystems. The average pH value of the upper 40 cm was 5.2.

SBSd/12 BOGS

BIOGEOCLIMATIC UNIT: SBSd

ECOSYSTEM UNIT: SBSd/12; *Picea mariana* - *Ledum groenlandicum* - *Sphagnum capillaceum*; Bog ecosystems.

ECOLOGICAL MOISTURE REGIME: Hygric - subhydric

ECOLOGICAL NUTRIENT REGIME: Oligotrophic - submesotrophic

DISTRIBUTION: Scattered throughout but very local; less common in the southern parts of the subzone.

PHYSIOGRAPHIC FEATURES:

Slope Positions: Depressional.

Slope Range: 0 (level)

Surface Shape: Straight (flat) but hummocky.

	A	B	C	D	E
1					
2					
3					
4					
5					
6	■	■			
7	■	■			

Aspect: Not applicable.

STRATA COVERAGE (%): A: 24 B: 52 C: 18 D: 96

GROUND COVERAGE (%): H: 98 MS: 0 DW: 2 R&S: 0

SBSd/12 BOGS

VEGETATION:

Tree Layer: trees scattered and clumped, with very poor growth.

Picea mariana	(black spruce)	-constant dominant

Shrub Layer: very well-developed, but not vigourous.

P. mariana		-regeneration and stunted mature individuals
Ledum groenlandicum	(Labrador tea)	-constant dominant

Herb Layer: poorly developed, dominated by dwarf evergreen shrubs rather than sedges or forbs.

Gaultheria hispidula	(creeping-snowberry)	
[*Vaccinium oxycoccos*	(bog cranberry)]	-always present but with low cover

Moss Layer: very well-developed; a thick carpet of mosses dominated by *Sphagnum* spp., but with a good diversity of lichens as well.

Sphagnum capillaceum	(sphagnum or peat moss)	-constant dominant
Pleurozium schreberi	(red-stemmed feather moss)	-localized on higher, drier microsites
[*Ichmadophila ericetorum*]		
[*Sphagnum fuscum*	(sphagnum or peat moss)]	
[*Sphagnum magellanicum*	(sphagnum or peat moss)]	
[*Sphagnum recurvum*	(sphagnum or peat moss)]	
[*Cladina mitis* and *C. rangiferina*]		
[*Cladonia* spp.]		

Comments: black spruce - Labrador tea - *Sphagnum* bogs are very poor in available nutrients, resulting in a very distinctive vegetation of poorly growing or stunted black spruce with a ground cover of Labrador tea and peat moss.

SBSd/12 BOGS

SOILS:

General Description: These are organic soils that have Of horizons that dominate the upper 40 cm of the profile, however, lower horizons vary in stages of decomposition. The water table varies seasonally, but is usually below the Of horizons. The pedons are poorly to very poorly drained on level to depressional landscapes.

Associated Classifications:

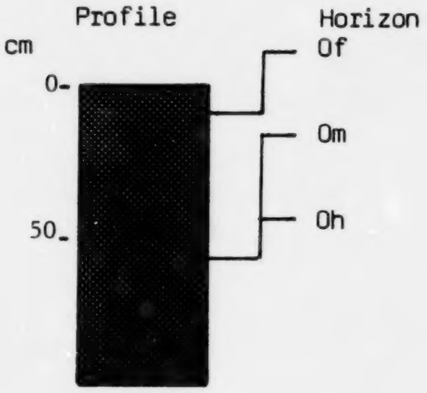
Soil: Fibrisols, Mesisols, and Humisols

Terrain: Organic blankets

Humus Form: Histomor

Parent Materials: Plant residues

Schematic Profile:



Description

-plant residues show little evidence of decomposition; erect; few roots.

-plant residues show moderate decomposition; massive; few roots.

-well-decomposed plant residues; massive; few to no roots.

Key Characteristics:

- organic blankets, dominated by fibric horizons in the upper tier.

SBSd/12 BOGS

Bogs range from open and treeless to fairly heavily treed types, often arranged concentrically about a central depression of open water. In our studies, we have sampled only the treed or forested bogs.

Black spruce is one of the most characteristic species of our sub-boreal bogs, but it usually is stunted, clumped, and rarely forms a true tree canopy.

The well-developed shrub layer is dominated by *Ledum groenlandicum* and stunted or regenerating black spruce.

Gaultheria hispidula and *Vaccinium oxycoccos* are two dwarf evergreen-leaved shrubs that characterize the poorly developed dwarf shrub/herb layer. *Carex aquatilis*, *C. pauciflora*, *Eriophorum vaginatum*, and *E. brachyantherum* also occur frequently, but with low cover.

The moss layer is very well-developed and dominated by species of *Sphagnum*, in the SBSd most characteristically *S. capillaceum*, with lesser amounts of *S. fuscum*, *S. magellanicum*, and *S. recurvum*. *Pleurozium schreberi* is a constant minor species, usually localized on higher drier hummocks or at tree bases. Although bogs have a high water table, their surfaces often dry out in the summer, especially atop raised, hummocky areas. Hence, lichens also grow in bogs, sometimes in surprising number and abundance. Most frequent are species of Cladoniae, the reindeer lichens (*Cladina mitis* and *C. rangiferina*) and numerous species of the less intricately branched *Cladonia*.

Of horizons dominate the upper 40 cm of the organic soils found in the bogs; however, lower horizons are in varying stages of decomposition, as reflected by soil classification of these pedons as Fibrisols, Mesisols, or Humisols. The common humus form is a Histomor. The average pH value of the upper 40 cm was 2.9.

8.3 ECOSYSTEM UNITS OF THE SBSe1: SUBALPINE FIR SUBZONE, WESTERN VARIANT

- /01 Mesic Bunchberry - moss ecosystem association
  - /01.1 Black huckleberry subassociation
    - /01.1(a) Coarse textured phase
    - /01.1(b) Fine textured phase
    - /01.1 Pine - aspen - forb stages
  - /01.2 Five-leaved bramble subassociation
    - /01.2(a) Coarse textured phase
    - /01.2(b) Fine textured phase
    - /01.2 Aspen - shrub - forb stages

- /02 Pine - lichen ecosystem association

- /03 Pine - moss ecosystem association
  - /03(a) Coarse textured phase
  - /03(b) Lithic phase

- /04 Submesic bunchberry - moss ecosystem association
  - /04(a) Coarse textured phase
  - /04(b) Fine textured phase

- /05 Pine - black spruce ecosystem association

- /06 Moist thimbleberry - forb ecosystem association

- /07 Oak fern ecosystem association
  - /07(a) Coarse textured phase
  - /07(b) Fine textured phase

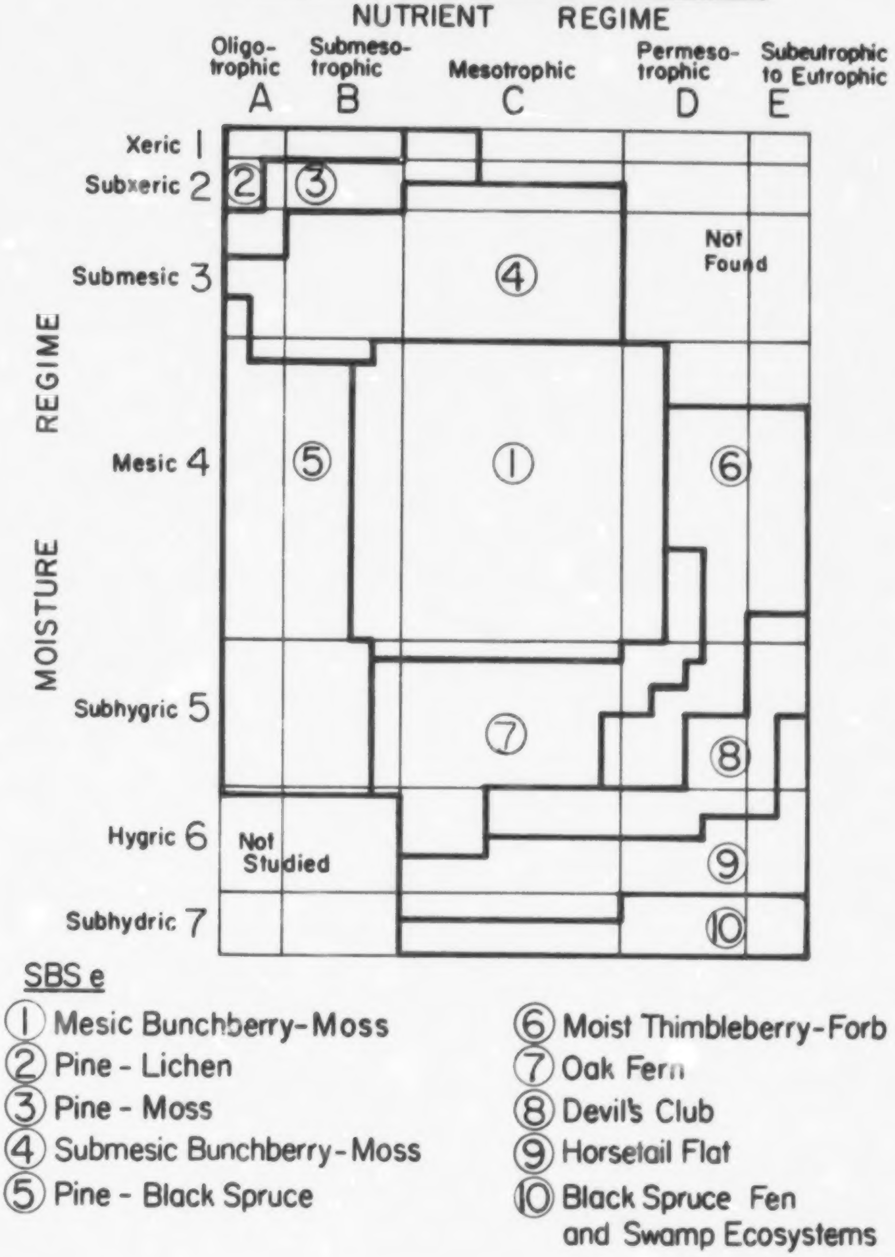
- /08 Devil's club ecosystem association
  - /08(a) Coarse textured phase
  - /08(b) Fine textured phase

- /09 Horsetail flat ecosystem association
  - /09(a) Coarse textured phase
  - /09(b) Fine textured phase

- /10 Black spruce fen and swamp ecosystems

Figure 9.

Edatopic Grid of Ecological Moisture and Nutrient Regime -SBSe1


NUTRIENT REGIME
Oligo-trophic A
Submeso-trophic B
Mesotrophic C
Permeso-trophic D
Subeutrophic to Eutrophic E
MOISTURE REGIME
Xeric 1
Subxeric 2
Submesic 3
Mesic 4
Subhygric 5
Hygric 6
Subhydric 7
Not Found
Not Studied
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
SBS e
① Mesic Bunchberry-Moss
② Pine - Lichen
③ Pine - Moss
④ Submesic Bunchberry-Moss
⑤ Pine - Black Spruce
⑥ Moist Thimbleberry-Forb
⑦ Oak Fern
⑧ Devil's Club
⑨ Horsetail Flat
⑩ Black Spruce Fen and Swamp Ecosystems

SBSel/01 MESIC BUNCHBERRY - MOSS

BIOGEOCLIMATIC UNIT: SBSel

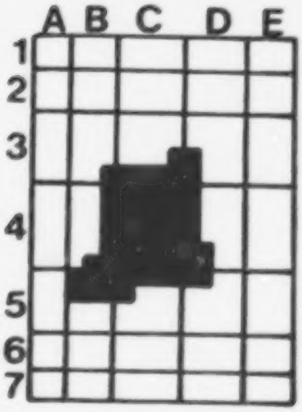
ECOSYSTEM UNIT: SBSel/01; *Picea glauca* x *engelmannii* - *Abies lasiocarpa* - *Cornus canadensis* - *Pleurozium schreberi* - *Ptilium crista-castrensis*; Mesic bunchberry - moss ecosystem association.

ECOLOGICAL MOISTURE REGIME: Mesic

ECOLOGICAL NUTRIENT REGIME: Mesotrophic - permesotrophic

DISTRIBUTION: Widespread throughout the subzone.

PHYSIOGRAPHIC FEATURES:
Slope Positions: Virtually all slope positions; usually middle and upper slopes.
Slope Range: 0 to 30%
Surface Shape: Variable, straight, slightly concave or convex.



Aspect: All

STRATA COVERAGE (%): A: 53 B: 55 C: 50 D: 82

GROUND COVERAGE (%): H: 90 MS: trace DW: 10 R&S: trace

SBSe1/01 MESIC BUNCHBERRY - MOSS

VEGETATION:

Tree Layer: stands usually well-stocked; trees with fair to good growth.

*Pinus contorta	(lodgepole pine)
Abies lasiocarpa	(subalpine fir)
Picea glauca x engelmanii	(hybrid white spruce)
[*Populus tremuloides	(trembling aspen)]

Shrub Layer: usually moderately developed, often with abundant advanced regeneration.

A. lasiocarpa		) -regeneration
[P. glauca x engelmannii]		)
Vaccinium membranaceum		-often dominant
[Lonicera involucrata	(black twinberry)]	) -frequent but
[Ribes lacustre	(black gooseberry)]	) with poor to
[Viburnum edule	(highbush-cranberry)]	) fair vigour;
		) not good
		) indicators.
[*Alnus viridis	(Sitka or green alder)]	-sometimes abundant
[*Shepherdia canadensis	(soopolallie)]	
[*Rubus parviflorus	(thimbleberry)]	

Herb Layer: moderately developed.

Cornus canadensis	(bunchberry)	) -constant
Rubus pedatus	(five-leaved bramble)	) dominant
Linnaea borealis	(twinflower)	)
Arnica cordifolia	(heartleaved arnica	) -all good
[Orthilia secunda	(one-sided wintergreen)]	indicators
[Lycopodium annotinum	(stiff club-moss)]	)
[Clintonia uniflora	(queen's cup)]	)
[Petasites palmatus	(palmate colt's-foot)]	-poor vigour

Moss Layer: very well-developed; typically a thick carpet of feather mosses.

Pleurozium schreberi	(red-stemmed feather moss)	) codominants
Ptilium crista-castrensis	(knight's plume feather moss)	)
Hylocomium splendens	(stepped feather moss)	
[Peltigera aphthosa]		
[Barbilophozia lycopodioides]		

SBSel/01 MESIC BUNCHBERRY - MOSS

SOILS:

General Description: The soils have developed on glacially transported parent materials that commonly form morainal blankets. Ae horizons are generally present and overlie Bm, Bf, or Bt horizons. Unaltered parent materials can usually be found within one meter of the surface and effective rooting is between 30 cm and 50 cm. The texture and coarse fragment content vary considerably. The organic surface horizons average 8-10 cm thick and are dominated by a moderately decomposed F horizon.

Associated Classifications:

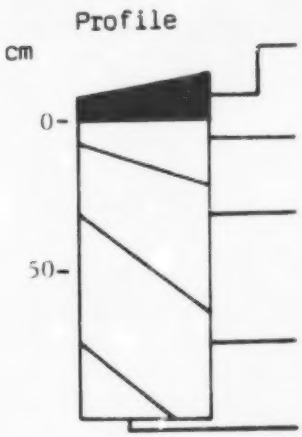
Soil: Orthic and Eluviated Dystric Brunisols; Humo-Ferric Podzols; Orthic, Brunisolic, Podzolic and Gleyed Gray Luvisols

Terrain: Morainal blankets

Humus Form: Hemimor, Humimor, Mormoder

Parent Materials: Glacial till

Schematic Profile:



Horizon	Description
L, F, (H)	-plant residues with the moderately decomposed F horizon predominating.
Ae	-grayish; weak structure; few to plentiful roots.
Bm, Bf, Bt	-reddish to dark brown; texture and structure vary, few to plentiful roots (Bt may restrict roots, air and water.)
BC	-transitional horizon to unaltered parent materials; very few roots.
C	-brown to olive brown; sandy, sandy loam or loamy sand; structureless; no roots.

Key Characteristics:
- moderately well-drained pedons with coarse fragments less than 35% by volume; commonly developed from glacial till forming morainal blankets on subdued topography.

Comments: Texture, coarse fragment content, and landform are accounted for in certain phases of this ecosystem unit.

SBSel/01.1 MESIC BUNCHBERRY - MOSS, BLACK HUCKLEBERRY SUBASSOCIATION

BIOGEOCLIMATIC UNIT: SBSel

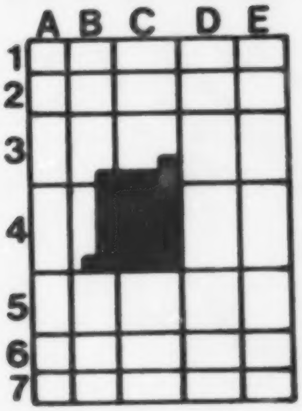
ECOSYSTEM UNIT: SBSel/01.1; *Picea glauca* x *engelmannii* - *Abies lasiocarpa* - *Vaccinium membranaceum* - *Cornus canadensis* - *Pleurozium schreberi* - *Ptilium crista-castrensis*; Mesic bunchberry - moss, black huckleberry subassociation.

ECOLOGICAL MOISTURE REGIME: Mesic

ECOLOGICAL NUTRIENT REGIME: Mesotrophic - (submesotrophic)

DISTRIBUTION: Widespread throughout the subzone

PHYSIOGRAPHIC FEATURES:
- Slope Positions: Variable; virtually all slope positions except crest; usually middle and upper.
- Slope Range: 0 to 40%, usually less
- Surface Shape: Variable, usually straight or slightly convex.



Aspect: All

STRATA COVERAGE (%): A: 53 B: 58 C: 55 D: 80

GROUND COVERAGE (%): H: 91 MS: trace DW: 9 R&S: trace

VEGETATION: as for SBSel/01.

COMMENTS: The black huckleberry subassociation is typical for the Mesic bunchberry - moss e.a., and is the one we usually find in the SBSe of our area.

SBSe1/01.1(a) MESIC BUNCHBERRY - MOSS, BLACK HUCKLEBERRY SUBASSOCIATION, COARSE TEXTURED PHASE

SOILS:

General Description: The soils have developed from coarse textured, glacially transported and deposited parent material. The typical pedon has horizons reflecting eluviation (grayish Ae) and subsequent illuviation (brownish Bf or Bm). A transitional horizon (BC) to the original parent material is found starting at less than one meter deep. The soils are often on gently undulating, well to moderately well-drained terrain.

Associated Classifications:

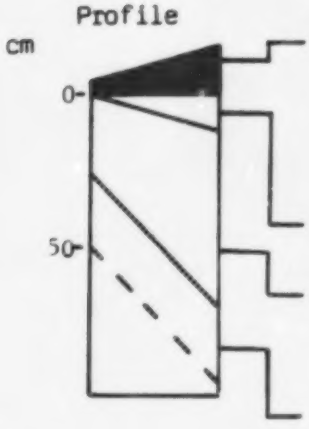
Soil: Humo-Ferric Podzols; Orthic and Eluviated Dystric Brunisols

Terrain: Morainal blankets (infrequently on fluvial and fluvialglacial terraces)

Humus Form: Hemimor

Parent Materials: Gravelly glacial till (infrequently fluvial sediments)

Schematic Profile:



Horizon	Description
(L), F, (H)	-moderately decomposed F horizon with recognizable fungal mycelia of various colors (white, yellow, etc.). May be overlain by a thin L, and underlain by a H horizon with particles of charcoal.
Ae	-light brownish gray; loamy sand; few roots.
Bf(Bm)	-brown to dark yellowish brown; sandy loam; weakly structured horizon with plentiful roots.
BC	-olive brown; sandy loam; structureless; very few roots; underlain by original parent material.

Key Characteristics:

- coarse texture; coarse fragment content varies
- well to moderately well-drained
- morainal blanket (infrequently fluvial)
- eluviated
- trend toward podzolization over time

Comments: We believe that this phase with the coarse texture probably overlies a finer parent material or other materials that restrict a rapid drainage at depth (1-3 meters might approximate that depth; however, studies are incomplete).

SBSe1/01.1(b) MESIC BUNCHBERRY - MOSS, BLACK HUCKLEBERRY SUBASSOCIATION, FINE TEXTURED PHASE

SOILS:

General Description: The soil profiles are characterized by a fine textured subsurface horizon (Bt) showing clay skins on ped surfaces and in pores. The Bt horizon is overlain by a whitish gray (Ae) and/or reddish brown (Bm or Bf) loamy surface mineral horizon. There may be a transitional horizon (AB) separating the Bt and surface horizons. The organic horizons generally range from 5 to 15 cm in total thickness with the F horizon most expressed. The pedons are moderately well to imperfectly drained.

Associated Classifications:

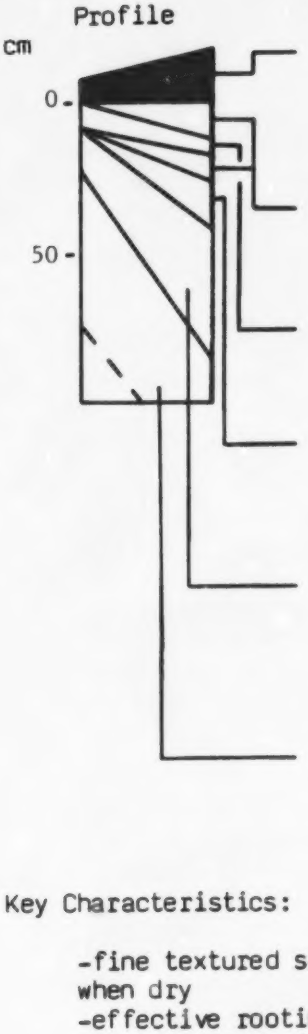
Soil: Brunisolic & Orthic Gray Luvisols (occasionally Gleyed and Podzolic subgroups) dominate with a limited occurrence of Orthic Dystric Brunisols

Terrain: Morainal blanket

Humus Form: Hemimors, Mormoders

Parent Materials: Glacial till

Schematic Profile:



Horizon	Description
(L), F, (H)	-discontinuous litter over a slightly to moderately decomposed F; light to dark brown; fungal and/or faunal decomposers with possibly a well-decomposed dark brown to black H.
Bm/Bf	-reddish brown; loam; fine subangular blocky peds; plentiful fine and medium roots.
Ae	-light gray; loam to sandy loam; sub-angular blocky to platy peds; plentiful fine roots.
AB	-grayish brown; loam to clay loam; sub-angular blocky; few to plentiful fine roots; few clay skins on peds and in pores.
Bt(x)	-dark brown; loam to clay loam; mottling not uncommon; massive and often compact or fragic, few roots; clay skins on coarse fragments and on peds.
BC	-variable depth; brown; loam; massive; very few roots; over parent materials.

Key Characteristics:

-fine textured subsurface horizons that are often compact or fragic, hard when dry
-effective rooting generally shallow, rarely exceeds 50 cm
-structureless (massive) Bt with clay skins, mottling not uncommon
-development from glacially transported parent materials that contain appreciable clay; may be overlain by a relatively thin ablation till

Comments: The soil profile of this phase may indicate slightly moister and richer conditions than mesic and mesotrophic. However, the massive and compact subsurface horizons limit rooting depth, availability of total nutrients, and restrict free movement of soil, air and water.

SBSel/01.2 MESIC BUNCHBERRY - MOSS, FIVE-LEAVED BRAMBLE SUBASSOCIATION

BIOGEOCLIMATIC UNIT: SBSel

ECOSYSTEM UNIT: SBSel/01.2; *Picea glauca* x *engelmannii* - *Abies lasiocarpa* - *Cornus canadensis* - *Rubus pedatus* - *Pleurozium schreberi* - *Ptilium crista-castrensis*; Mesic bunchberry - moss, five-leaved bramble subassociation.

ECOLOGICAL MOISTURE REGIME: Mesic - (subhygric)

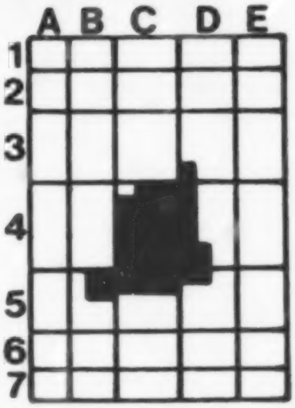
ECOLOGICAL NUTRIENT REGIME: Mesotrophic - permesotrophic

DISTRIBUTION: Scattered throughout the subzone, but generally not abundant.

PHYSIOGRAPHIC FEATURES:

Slope Positions: Variable; if upper, slope gradients tend to be lower; generally occurs downslope of contiguous SBSel/01.1.

Slope Range: 0 to 27%, usually less than 20%



Aspect: Variable, but tends to be northerly.

Surface Shape: Variable, straight to concave or slightly convex.

STRATA COVERAGE (%): A: 54 B: 40 C: 48 D: 83

GROUND COVERAGE (%): H: 90 MS: 1 DW: 9 R&S: 0

SBSel/01.2 MESIC BUNCHBERRY - MOSS, FIVE-LEAVED BRAMBLE SUBASSOCIATION

VEGETATION:

Tree Layer: stands usually well-stocked; tree growth good, usually slightly better than in the _Vaccinium_ subassociation.

Picea glauca x _engemannii_	(hybrid white spruce)
Abies lasiocarpa	(subalpine fir)
*_Pinus contorta_	(lodgepole pine)
[*_Populus tremuloides_	(trembling aspen)]

Shrub Layer: moderately developed; advanced regeneration abundant.

A. lasiocarpa		) -regeneration
[_P. glauca_ x _engelmannii_]		)
[_Viburnum edule_	(highbush-cranberry)]	
[_Rosa acicularis_	(prickly rose)]	
[_Vaccinium membranaceum_	(black huckleberry)]	
[_Lonicera involucrata_	(black twinberry)]	
[_Ribes lacustre_	(black gooseberry)]	
[_Rubus parviflorus_	(thimbleberry)]	

Herb Layer: moderately developed.

Cornus canadensis	(bunchberry)	) -characteristic
Rubus pedatus	(five-leaved bramble)	) dominants
[_Linnaea borealis_	(twinflower)]	
[_Lycopodium annotinum_	(stiff club-moss)]	
[_Orthilia secunda_	(one-sided wintergreen)]	
[_Arnica cordifolia_	(heartleaved arnica)]	
[_Petasites palmatus_	(palmate colt's-foot)]	

Moss Layer: very well-developed; typically a thick carpet of feather mosses.

Pleurozium schreberi	(red-stemmed feather moss)	) -codominants
Ptilium crista-castrensis	(knight's plume feather moss))	
Hylocomium splendens	(stepped feather moss)	
[_Peltigera aphthosa_]		
[_Barbilophozia lycopodioides_]		

Comments: The SBSel/01.2 or _Rubus_ subassociation can be distinguished from the SBSel/01.1 or _Vaccinium_ subassociation by the lack or relative scarcity of _V. membranaceum_ and the presence and abundance of _R. pedatus_.

SBSel/01.2(a) MESIC BUNCHBERRY - MOSS, FIVE-LEAVED BRAMBLE SUBASSOCIATION, COARSE TEXTURED PHASE

SOILS:

General Description: The soils have formed on materials that have been transported by water with subsequent sedimentation. The particle size is mostly coarse-loamy and, at times, skeletal. The older profiles show a trend towards podzolization while the younger ones are regosolic. Restrictive layers are rare and effective rooting depths average more than 60 cm. Drainage is moderately good to rapid and this unit occurs on all slope positions but the toe and crest.

Associated Classifications:

Soil: Orthic and Eluviated Dystric Brunisols, Orthic Regosols

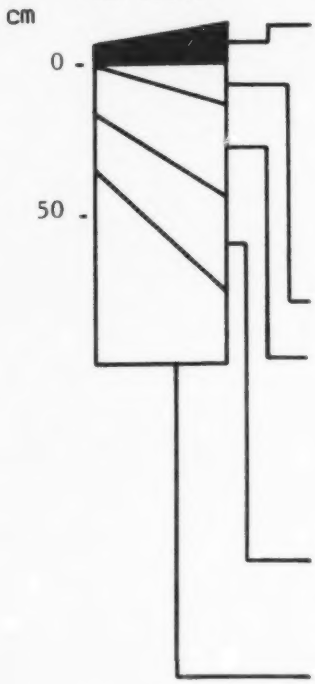
Terrain: Fluvial and fluvial-glacial terraces and fans

Humus Form: Hemimor

Parent Materials: Coarse-loamy to skeletal fluvial and fluvialglacial sediments

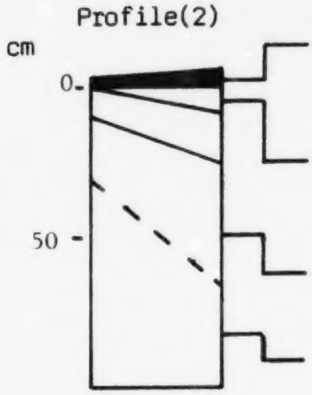
Schematic Profiles:

Profile(1)



Horizon	Description
(L), F, (H)	-moderately decomposed F horizon; common fungal mycelia with relatively few insect droppings; dark brown; matted; plentiful roots and may be underlain by a thin H horizon sharply delineated from the mineral soil. A discontinuous litter (L) horizon is intermixed with the moss layer on top of the solum.
Ae	-grayish brown; loam; few roots
Bm(Bf)	-dark yellowish to reddish brown; sandy loam to loamy sand; weak structure; plentiful roots. Distinguishing a Bm from Bf is morphologically difficult in this particular ecosystem unit. Chemical analysis is generally required.
BC	-dark grayish to yellowish brown; sandy loam to loamy sand; weak structure; few roots.
C	-brown to olive brown; sandy, sandy loam or loamy sand; structureless; no roots.

Schematic Profiles:



Horizon	Description
(L), F, (H)	-moderately decomposed plant materials; slightly matted; plentiful to abundant roots; H horizon, if present, granular.
Ah	-very dark grayish brown; loam to sandy loam; plentiful roots; weak granular structure.
C	-yellowish brown; sand; sandy loam, or loamy sand; few roots; structureless.
IIC	-color and textures of C horizons will vary depending upon parent materials and sedimentation processes.

Key Characteristics:

- fluvial and fluvialglacial terraces and fans
- coarse texture
- drainage is moderately good to rapid

SBSel/01.2(b) MESIC BUNCHBERRY - MOSS, FIVE-LEAVED BRAMBLE SUBASSOCIATION, FINE TEXTURED PHASE

SOILS:

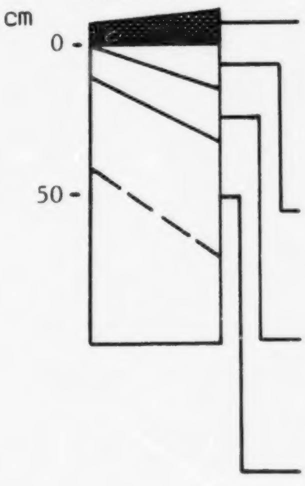
General Description: Soils of this phase characteristically show a well-developed horizon of clay eluviation (Ae) and subsequent horizons of illuviation (Bt). Parent materials are fine textured tills that form morainal blankets. The organic and mineral horizons are usually separated by a layer of charcoal. The predominant organic horizon is a moderately decomposed, matted F horizon. The litter is often sparse and intermixed with the bryophytic vegetation. H horizons may be lacking; however, when present, they are associated with a large amount of charcoal, and often adhere to the mineral interface. The pedons are moderately well to imperfectly drained and seepage may be present, particularly during the early growing season.

Associated Classifications:

Soil: Orthic, Brunisolic and Podzolic Gray Luvisols (may have Gleyed subgroups)	Terrain: Morainal blankets
Humus Form: Hemimor	Parent Materials: Fine-loamy (to clayey) glacial till

Schematic Profile:

Profile



Horizon	Description
L, F, (H)	-leaves, needles, and twigs intermixed with mosses over a moderately decomposed F; matted; common to abundant fungal mycelia; a well-decomposed H horizon with relatively large amounts of charcoal may be present.
(Bm/Bf)	-dark to dark yellowish brown; loam to sandy clay loam; moderate subangular blocky structure; plentiful fine roots.
Ae	-grayish brown; sandy loam to loam; weak subangular blocky structure; plenfiful fine, medium, and coarse roots.
Bt	-brown to light olive brown; sandy clay loam to clay loam; few roots; moderately thick clay skins on ped faces and very few roots; clay skins on ped faces; over a BC or C horizon.

Key Characteristics:

- Ae and Bt horizons
- Fine-loamy (to clayey) particle size
- Morainal blankets

SBSel/01 MESIC BUNCHBERRY - MOSS

The Mesic bunchberry - moss ecosystem association is zonal for the SBSe. This means that the SBSel/01 represents a group of ecosystems that best reflect the regional climate of the land area that we have classified and mapped as the subalpine fir subzone of the Sub-Boreal Spruce Biogeoclimatic Zone. Not surprisingly, more than 50% of the area of the SBSel is occupied by the Mesic bunchberry - moss e.a.

Almost all SBSel/01 ecosystems have been burned at least once within the past 150 years. Thus, most forest stands are in some sucessional stage; relatively few have attained the theoretical climax state. We characterize the mature climax plant association as _Picea_ _glauca_ x _engelmannii_ - _Abies_ _lasiocarpa_ - _Cornus_ _canadensis_ - _Pleurozium_ _schreberi_ - _Ptilium_ _crista-castrensis_. However, most commercial stands that one encounters are between 85 and 150-180 years old, and are in some sort of late seral or early climax stage. Such forests are usually mixtures of lodgepole pine, spruce and subalpine fir, sometimes with minor aspen. With increasing stand age _Abies_ increases at the expense of all other species, even _Picea_. Spruce is a climax species, but its natural regeneration is much less frequent than that of subalpine fir and usually occurs in natural openings or on decaying wood.

Vaccinium _membranaceum_ typically dominates the moderately well-developed shrub layer, especially in older stands, and is often joined by abundant _Abies_ regeneration. _Alnus_ _viridis_ is very abundant in some areas, especially in the southeastern part of the Prince Rupert Region. _Menziesia_ _ferruginea_ and _Vaccinium_ _ovalifolium_ sometimes are abundant, especially in the wetter western and northern extremities of the subzone (western Morice and Bulkley and northern Kispiox T.S.A.'s). Spruce regeneration, *Ribes lacustre*, *Lonicera involucrata*, and *Viburnum edule* are all common but generally not abundant. Species such as *Shepherdia canadensis*, *Rubus parviflorus*, *Rosa acicularis*, and *Spiraea betulifolia* are common in younger forests, but they usually do not persist in older stands. Most of the shrubbery occurs in the low shrub layer. The tall shrub layer is generally poorly developed unless there is lots of vigourous *Alnus viridis* or tree regeneration.

Familiar and widespread species such as *Cornus canadensis*, *Rubus pedatus*, *Linnaea borealis*, *Arnica cordifolia*, *Orthilia secunda*, and *Lycopodium annotinum* dominate the moderately well developed herb layer. *C. canadensis*, *L. borealis*, *O. secunda*, and *L. annotinum* are all so-called circumboreal species, distributed around the globe at boreal latitudes. *Petasites palmatus*, *Pyrola chlorantha*, *Clintonia uniflora*, and *Vaccinium caespitosum* are also common, and may be abundant on some sites. Seral stands often have an abundance of *Lathyrus nevadensis*, *Aster conspicuus*, *Epilobium angustifolium*, and grasses such as *Calamagrostis canadensis*, *Elymus glaucus*, and *Festuca occidentalis*.

Feather or weft-forming mosses dominate the moss layer, typically forming a near-continuous carpet that is usually cool and moist, except during prolonged hot dry spells. *Pleurozium schreberi* and *Ptilium crista-castrensis* dominate; *Hylocomium splendens* is almost always present but usually has relatively minor coverage. *Barbilophozia lycopodioides*, *Dicranum fuscescens*, and *Peltigera aphthosa* are frequent but not abundant. *Rhytidiopsis robusta* is generally uncommon but may be abundant in the wetter portions of the subzone.

The Mesic bunchberry - moss e.a. is by far the most common and widespread ecosystem association of the SBSel. Hence it encompasses a fairly wide range of variation in physiography, soil, and vegetation. It is necessary to recognize some of this variation, especially for management purposes.

To begin with, there seem to be two subassociations: the SBSel/01.1 or *Vaccinium membranaceum* subassociation, and the SBSel/01.2 or *Rubus pedatus* subassociation. The *Vaccinium* subassociation typifies the ecosystem association as a whole, and is widespread. The *Rubus* subassociation seems to occur on slightly moister and richer sites than the *Vaccinium* subassociation, tends to be found either on gentle slopes or, if on steeper gradients (say greater than 15%), in positions downslope of adjacent SBSel/01.1 on the same slope. The SBSel/01.2 is also less frequent and spottier in distribution.

The lack or scarcity of *Vaccinium membranaceum* in combination with the presence and abundance of *Rubus pedatus* distinguishes the *Rubus* subassociation. Additional species that may occur or be abundant in the SBSel /01.2 and help differentiate it from the SBSel/01.1 are *Alnus incana*, *Ribes lacustre*, *Oplopanax horridus*, *Viburnum edule*, *Spiraea douglasii*, *Gymnocarpium dryopteris*, *Smilacina racemosa*, *Streptopus roseus* and *S. amplexifolius*, *Tiarella trifoliata*, and *Actaea rubra*. All these species generally prefer edaphic conditions moister and richer than mesic and mesotrophic.

Each subassociation has several phases based on differences in soil.

Soil Phases

There are four phases (two per subassociation) based on differences in soil texture. Vegetation (at least in older stands) looks similar, but there are important textural differences with implications for management.

SBSel/01.1(a) Coarse textured phase

This phase often occurs above 800 m on gently undulating, well-to moderately well-drained terrain. Typically, the soils have developed from coarse textured, glacially transported and deposited parent materials. The landforms are morainal blankets; however, the phase is also infrequently found on fluvial and fluvialglacial terraces. The soils may be classified as Humo-Ferric Podzols or Orthic and Eluviated Dystric Brunisols and the humus form is almost always a Hemimor. The dominant organic horizon is a fungal, matted, moderately decomposed F, while a thin H horizon may be present beneath the F. The typical mineral profile has horizons reflecting eluviation (Ae) and subsequent illuviation (Bf or Bm). These profiles show a trend toward podzolization over time. The pH of the organic horizons was 3.7 and the pH in the mineral rooting zone was 4.3.

The coarse nature of these profiles may not extend deep into the solum, and at depth (1-3 metres) finer textured parent materials may restrict rapid drainage, effectively helping to increase and extend the length of the storage and availability of the moisture in these ecosystems.

SBSel/01.1(b) Fine textured phase

The soils of this phase have developed from finer textured glacial till deposited as moderately well to imperfectly drained morainal blankets. Genetic development is usually luvisolic (various subgroups), characterized by clay skins in the Bt horizon on peds and coarse fragments. These horizons are often massive, compact, and at times fragic (Btx). When such development occurs close to the surface, and under moist and windy conditions, blowdown on edges of opened stands is likely (Trowbridge et al. 1980).

A fungal or faunal F is the dominant horizon in the surface organic layer; hence, humus forms are either Hemimors or Mormoders.

The organic horizons' pH value averaged 3.6; average pH was 4.2 in the mineral rooting zone.

SBSel/01.2(a) Coarse textured phase

Soils are coarse textured, sometimes skeletal, have developed on fluvial and fluvialglacial terraces and fans, and are moderately well to rapidly drained. They have been classified as Orthic and Eluviated Dystric Brunisols, Orthic Regosols, and Orthic Humo-Ferric Podzols. The humus form is a Hemimor.

The average pH of the organic horizons are 4.1 and in the mineral rooting zone average pH was 4.4. However, when the averages of the mineral pH's are segregated as Podzols, Brunisols, and Regosols, the values are 3.5, 4.5 and 5.2, respectively.

SBSel/01.2(b) Fine textured phase

These ecosystems develop on fine textured glacial till. The morainal blankets show evidence of clay eluviation in the Ae horizons and subsequent illuviation in the Bt and Btg horizons. The profiles are moderately well to imperfectly drained and seepage is often present in the early growing season, just after thaw. The soils have been classified as Orthic, Brunisolic, and Podozolic Gray Luvisols, with some occurrence of Gleyed subgroups. The humus form is a Hemimor with a dominant fungal, matted F horizon.

The average pH values were 3.7 in the organic horizons and 4.2 in the mineral rooting zone.

Successional Variation in Vegetation

The ubiquitous fire history of the SBS has produced a diverse array of successional plant communities on many zonal sites. Species composition and vegetation structure are continually changing with time throughout succession. We have not sampled enough seral ecosystems to describe them properly or to chronicle their succession (cf Runka 1972; Cotic et al. 1974). However there are some general features of the vegetation that help characterize the most widespread seral stages of the SBSe1/01.

SBSe1/01.1: Pine - aspen - forb stages

These seral stages have more pine and aspen than in older zonal forests, although spruce and subalpine fir still usually dominate the regeneration. Other seral species such as *Spiraea betulifolia*, *Shepherdia canadensis*, *Rosa acicularis*, *Rubus parviflorus*, *Lathyrus nevadensis*, *Aster conspicuus*, *Epilobium angustifolium*, and additional forbs and grasses are abundant. The moss layer is often poorly developed especially in stands with lots of aspen and deciduous shrubs.

SBSe1/01.2: Aspen - shrub - forb stages

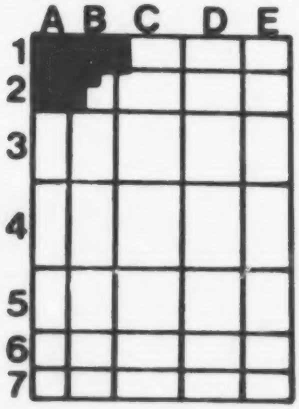
Seral stages of the *Rubus pedatus* subassociation usually seem to be dominated by aspen and to a lesser extent pine, mixed sometimes with paper birch. Spruce and subalpine fir are usually present, but generally scattered through the understory and as spotty regeneration. Abundant shrubs may include *Shepherdia canadensis*, *Spiraea betulifolia* and *S. douglasii*, *Rosa* *acicularis*, *Rubus parviflorus*, *Viburnum edule*, *Lonicera involucrata*, *Alnus viridis*, and *A. incana*. Frequent herbs include those of the Pine - aspen - forb stages as well as *Aralia nudicaulis*, *Thalictrum occidentale*, *Smilacina racemosa*, *Delphinium glaucum*, *Osmorhiza chilensis*, *Rubus pubescens*, *Festuca occidentalis*, *Oryzopsis asperifolia*, and *Calamagrostis canadensis*.

We have also noticed a third type of successional variation in the zonal ecosystem association. Many zonal stands have an abundance of *Alnus viridis*, most often as a vigourous tall shrub. Such stands seem to be common in drier parts of the SBSel(e.g., the eastern Lakes and Morice districts and over to Fort St. James); this may be related to fire history. *Alnus* is a nitrogen-fixing pioneer species and may have been a more successful invader in these drier areas where fires were hotter and removed much of the surface organic matter (J. van Barneveld, personal communication). The abundance of *Alnus viridis* is sometimes accompanied by a reduction in the *Vaccinium membranaceum*.

SBSel/02 PINE - LICHEN

BIOGEOCLIMATIC UNIT: SBSel

ECOSYSTEM UNIT: SBSel/02; *Pinus contorta* - *Arctostaphylos uva-ursi* - *Cladoniae*; Pine - lichen ecosystem association.



ECOLOGICAL MOISTURE REGIME: Xeric - subxeric

ECOLOGICAL NUTRIENT REGIME: Oligotrophic - submesotrophic

DISTRIBUTION: Uncommon in the study area.

PHYSIOGRAPHIC FEATURES:

Slope Positions: Level or crest; on fluvial terraces or along bedrock ridges.

Slope Range: 0 to 30%

Aspect: Variable; if on slope tends to southerly.

Surface Shape: Straight (flat) or convex.

STRATA COVERAGE (%): A: 31 B: 15 C: 25 D: 73

GROUND COVERAGE (%): H: 95 MS: trace DW: 2 R&S: 3

SBSe1/02 PINE - LICHEN

VEGETATION:

Tree Layer: open stands of poorly growing trees.

Pinus contorta	(lodgepole pine)	

Shrub Layer: sparse; poor vigour.

P. contorta		) -regeneration
[*Abies lasiocarpa*	(subalpine fir)]	)
[*Picea glauca* x *engelmannii*	(hybrid white spruce)]	)
Vaccinium membranaceum	(black huckleberry)	

Herb Layer: poorly developed.

Arctostaphylos uva-ursi	(kinnikinnick)	-characteristic dominant

Moss Layer: moderately developed, dominated by lichens.

Cladonia gracilis		
Cladonia ecmocyna		
Cladina mitis		
Cladina rangiferina	(reindeer lichen)	

Comments: the relative abundance of *Arctostaphylos uva-ursi* and the dominance of the "moss" layer by lichens rather than mosses are diagnostic for the Pine-lichen ecosystem association.

SBSe1/02 PINE - LICHEN

SOILS:

General Description: These soils have developed on sandy to sandy-skeletal fluvial and fluvialglacial landforms. Soil pedons are rapidly drained and have deep rooting. A light to dark yellowish brown Bm (or Bf) horizon may be overlain by a thin, leached grayish brown surface mineral horizon (Ae). Organic surface horizons are thin (2-3 cm) and consist primarily of a matted, moderately decomposed F horizon with obvious fungal mycelia. Charcoal is often found at the organic - mineral interface.

Associated Classifications:

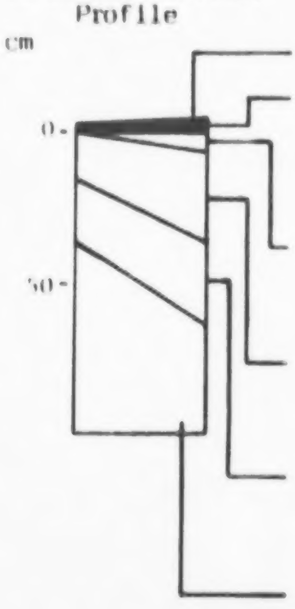
Soil: Orthic and Eluviated Dystric Brunisols; Orthic Humo-Ferric Podzols

Terrain: Fluvialglacial outwash; kame and fluvial terraces

Humus Form: Xeromors

Parent Materials: Coarse fluvial sediments

Schematic Profile:



Horizon	Description
L	-coniferous litter and lichens.
F	-moderately decomposed plant residues; firm, crusty, compact matted; abundant fine roots; charcoal; yellow and white mycelia; abrupt boundary.
Ae	-grayish brown; sandy loam; weak structure; loose; plentiful roots; abrupt boundary.
Bm(Bf)	-dark (grayish) brown; sandy loam; weak subangular blocky; plentiful medium and coarse roots.
BC	-light yellowish brown; loamy sand; very weak subangular blocky; few fine, plentiful medium and coarse roots.
C	-yellowish brown; sand; structureless.

Key Characteristics:

- thin, crusty organic horizons
- sandy to sandy-skeletal particle size
- fluvialglacial and fluvial parent materials and landforms

SBSel/02 PINE - LICHEN

The Pine - lichen ecosystem association occupies the driest and often the poorest sites in the subalpine fir subzone. The SBSel/02 occurs on rapidly drained, coarse textured outwash or colluvial materials over bedrock, and presumably may also develop on eolian sands.

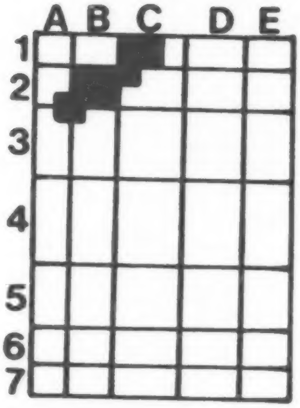
This ecosystem association is in large part a product of repeated fire; lodgepole pine thus dominates the tree layer. The pine stands are generally even-aged, sometimes overstocked, and usually growing poorly. Shrubs and taller herbs are scarce or nearly lacking. In the shrub layer there may be scattered regeneration of pine, subalpine fir, and spruce, as well as Vaccinium membranaceum and occasionally Juniperus communis. Arctostaphylos uva-ursi characterizes the poorly developed dwarf shrub/herb layer. The moss layer is fairly well-developed and typically dominated by fruticose (minature shrub-like) lichens, especially species of Cladonia, Cladina, and sometimes Stereocaulon. This dominance of the ground layer by lichens rather than mosses is diagnostic for the Pine - lichen e.a. Note also the scarcity of Peltigera spp. (dog lichens) on the forest floor.

The soils that we sampled had developed on sandy to sandy-skeletal fluvial and fluvialglacial land forms, namely outwash or kame and fluvial terraces. The pedons are rapidly drained and relatively deeply rooted. A thin, often crusty Xeromor humus form may overly an Ae or, more commonly, a Bm or Bf horizon. The soils have been classified as Orthic and Eluviated Dystric Brunisols and Orthic Humo-Ferric Podzols. The average pH values were 3.6 and 5.1 in the organic horizons and mineral rooting zone, respectively.

SBSel/03 PINE - MOSS

BIOGEOCLIMATIC UNIT: SBSle

ECOSYSTEM UNIT: SBSel/03; *Pinus contorta* - (*Abies lasiocarpa*) - *Vaccinium membranaceum* - *Pleurozium schreberi* - *Cladoniae*; Pine - moss ecosystem association.



ECOLOGICAL MOISTURE REGIME: Subxeric

ECOLOGICAL NUTRIENT REGIME: Oligotrophic - mesotrophic

DISTRIBUTION: Relatively uncommon but scattered throughout the subzone in suitable habitats.

PHYSIOGRAPHIC FEATURES:

Slope Positions: Variable, virtually all except toe slopes.

Slope Range: 0 to 15%

Surface Shape: Straight to convex.

Aspect: Variable

STRATA COVERAGE (%): A: 37 B: 53 C: 22 D: 82

GROUND COVERAGE (%): H: 88 MS: 0 DW: 4 R&S: 8

SBSe1/03 PINE - MOSS

VEGETATION:

Tree Layer:

**Pinus contorta*	(lodgepole pine)	
Picea glauca x *engelmannii*	(hybrid white spruce)	

Shrub Layer: moderately developed; fair vigour.

Abies lasiocarpa	(subalpine fir)	) -regeneration
[*P. glauca* x *engelmannii*		)
[**P. contorta*		)
Vaccinium membranaceum	(black huckleberry)	-characteristic dominant
[**Shepherdia canadensis*	(soopolallie)]	

Herb Layer: poorly developed.

**Arctostaphylos uva-ursi*	(kinnikinnick)
Linnaea borealis	(twinflower)
[*Chimaphila umbellata*	(pipsissewa)]
[*Vaccinium caespitosum*	(dwarf blueberry)]

Moss Layer: moderately well-developed; diverse.

Pleurozium schreberi	(red-stemmed feather moss)	-usually dominant
**Cladina mitis*		
**Cladina rangiferina*	(reindeer lichen)	
Cladonia gracilis		
Cladonia ecmocyna		
[*Cladonia chlorophaea*]		
[**Stereocaulon tomentosum*]		
[*Polytrichum juniperinum*	(hair cap moss)]	
[*Dicranum fuscescens*]		

Comments: the Pine-moss ecosystem association is more common in the study area than the Pine-lichen e.a., has less *Arctostaphylos uva-ursi*, and has a moss layer often with roughly equivalent amounts of lichens and mosses.

SBSel/03(a) PINE - MOSS, COARSE TEXTURED PHASE

SOILS:

General Description: These soils have developed on coarse textured, rapidly drained fluvialglacial terraces and fans. Organic surface horizons are relatively thin and mineral horizons contain appreciable (20 - 60% by volume) coarse fragments. The soil profile generally consists of a brownish Bm horizon which may be overlain by a thin, leached Ae horizon of lighter color. The thin, often crusty and matted surface organic layer contains common to abundant fungal mycelia. Charcoal is frequently found at the interface between mineral and organic horizons.

Associated Classifications:

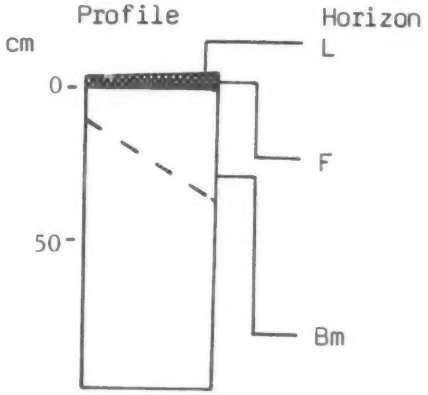
Soil: Orthic and Eluviated Dystric Brunisols

Humus Form: Xeromors

Terrain: Fluvialglacial outwash (terraces and fans)

Parent Materials: Fluvialglacial sediments

Schematic Profile:



Description

-thin, discontinuous and scattered coniferous plant litter; may be intermixed with mosses.

-moderately decomposed plant residues, primarily coniferous and bryophytic in origin; matted plentiful roots; abundant fungal mycelia; lower boundary has appreciable charcoal.

-dark yellowish brown; sandy loam to loam; few to plentiful roots; over original parent materials (C).

Key Characteristics:
- very rapidly to well-drained
- coarse textured, fluvialglacial parent materials, terraces and fans
- thin surface organic horizons

Comments: This phase may include sandy eolian parent materials.

SBSel/03(b) PINE - MOSS, LITHIC PHASE

SOILS:

General Description: These soils have developed on morainal veneers and residual materials over bedrock. Texture varies from loam, to clay loam on morainal materials to sandy loams on residual material, while drainage also varies from moderately good to rapid. The bedrock is usually within 50 cm of the soil surface. The dominant horizons are the moderately decomposed F in the organic surface layer and a Bm horizon in the mineral soil. However, in fragmental soils over bedrock there may be no genetic development in the pedon and the organic layer may lie over a C horizon.

Associated Classifications:

Soil: Eluviated Dystric Brunisols and Orthic Regosols

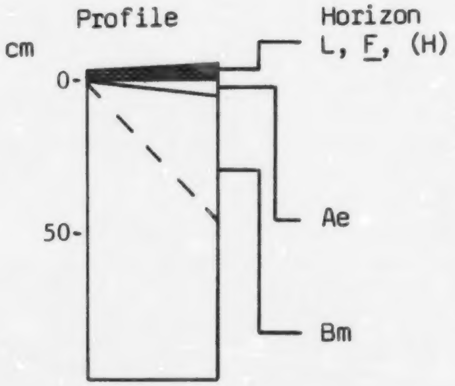
Humus Form: Xeromors

Terrain: Morainal veneer and residual materials over bedrock

Parent Materials: Glacial till and weathered bedrock

Bedrock Geology: Predominantly volcanics

Schematic Profile:



Description

-loose litter over moderately decomposed plant materials (F) that are matted and contain fungal mycelia as the primary decomposer. A thin H horizon may or may not be present.

-light grayish brown; sandy loam; few fine and plentiful medium and coarse roots.

-dark yellowish brown loam to clay loam; few to plentiful roots; over parent material (C) or bedrock (R).

Key Characteristics:

- thin organic horizons, crusty when dry
- shallow soil over bedrock

SBSel/03 PINE - MOSS

There seems to be another class of fire-endangered, seral pine forest on dry sites. The Pine - moss ecosystem association also occurs on rapidly drained, coarse textured (skeletal) fluvial deposits, or shallow morainal or residual soils over bedrock. However, moisture and nutrient conditions of the SBSel/03 appear not to be as extreme as those of the SBSel/02.

Lodgepole pine again dominates the tree stratum, but with increasing stand age subalpine fir and to a lesser extent spruce would gain in importance.

The shrub layer is moderately developed and characterized by *Vaccinium membranaceum*, regenerating subalpine fir, and *Shepherdia canadensis*. Spruce regeneration is infrequent, pine regeneration rare or lacking except in forest openings.

The herb layer is sparse to moderately developed; *Arctostaphylos uva-ursi*, *Linnaea borealis*, *Chimaphila umbellata*, and *Vaccinium caespitosum* are typical species. Note that these are all dwarf woody plants. *Melampyrum lineare* (cow-wheat) is an unusual but inconspicuous plant that may be found in both the Pine-lichen and Pine-moss e.a.'s. *M. lineare* is a small, yellow-flowered relative of *Castilleja* (Indian paintbrush), and similarly is a partial root parasite on other plants.

Lichens (especially species of Cladoniae) dominate the moderately to well-developed moss layer on drier sites with more open stands, but with increasing age and canopy closure mosses (especially *Pleurozium schreberi*) become codominant.

Not surprisingly, most of the forest stands belonging to the Pine-moss e.a. are still in various seral stages. With increasing stand age we would expect increased cover of subalpine fir, spruce, *Vaccinium membranaceum*, and mosses. However, succession in such ecosystems is slow, and they would have to remain undisturbed for a long time to reach a theoretical subalpine fir - (spruce) - *V. membranaceum* - *Pleurozium schreberi* climax.

There are two phases in this ecosystem association, the coarse textured phase and the lithic phase.

Soils in the coarse textured phase (SBSe1/03(a)) are Orthic and Eluviated Dystric Brunisols with a Xeromor humus form. Landforms are fluvialglacial outwash terraces and fans and are very rapidly to well-drained.

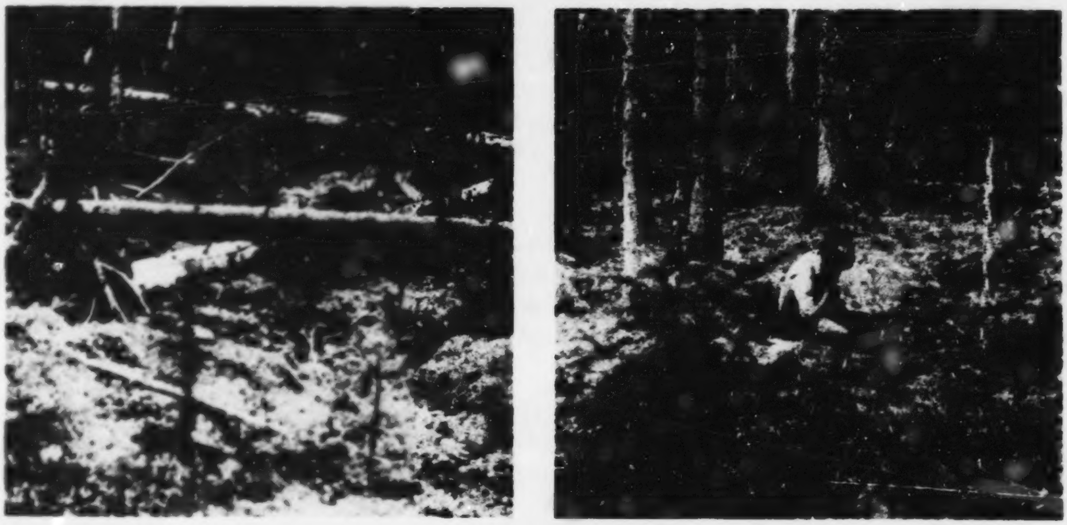
Soils in the lithic phase (SBSe1/03(b)) have developed on morainal veneers and residual materials over bedrock (predominantly volcanic). The soils described were classified as Eluviated Dystric Brunisols and Orthic Regosols with thin Xeromor humus forms. The soil texture varies but bedrock is within 1 m of the surface.

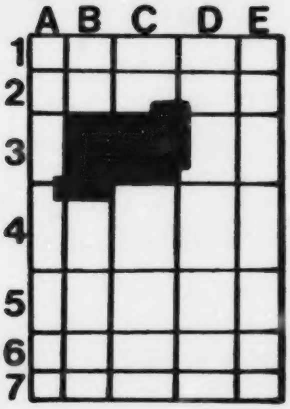
The pH of the organic component was 3.4 and that of the mineral rooting zone was 4.1.

SBSel/04 SUBMESIC BUNCHBERRY - MOSS

BIOGEOCLIMATIC UNIT: SBSel

ECOSYSTEM UNIT: SBSel/04; *Pinus contorta* - *Abies lasiocarpa* - *Picea glauca* x *engelmannii* - (*Vaccinium membranaceum*) - *Cornus canadensis* - *Pleurozium schreberi*; Submesic bunchberry - moss ecosystem association.





ECOLOGICAL MOISTURE REGIME: Submesic

ECOLOGICAL NUTRIENT REGIME: Submesotrophic - mesotrophic

DISTRIBUTION: Occurs throughout the subzone, but is much more common in the southern Morice and Lakes Timber Supply Areas.

PHYSIOGRAPHIC FEATURES:

Slope Positions: Middle, upper and crest, or level.

Slope Range: 0 to 50% Aspect: Variable

Surface Shape: Straight to convex.

STRATA COVERAGE (%): A: 56 B: 37 C: 38 D: 70

GROUND COVERAGE (%): H: 89 MS: trace DW: 11 R&S: trace

SBSe1/04 SUBMESIC BUNCHBERRY - MOSS

VEGETATION:

Tree Layer: young stands often densely stocked.

*Pinus contorta	(lodgepole pine)	-usually
Abies lasiocarpa	(subalpine fir)	dominant
Picea glauca x engelmannii	(hybrid white spruce)	

Shrub Layer: poorly to moderately developed, with fair vigour.

A. lasiocarpa		) -regeneration
[P. glauca x engelmannii]		)
Vaccinium membranaceum	(black huckleberry)	
Rosa acicularis	(prickly rose)	
[*Alnus viridis	(Sitka or green alder)]	
[*Shepherdia canadensis	(soopolallie)]	

Herb Layer: generally poorly developed and with only fair vigour.

Cornus canadensis	(bunchberry)	
Linnaea borealis	(twinflower)	
[*Epilobium angustifolium	(fireweed)]	-poor to fair
[*Aster conspicuus	(showy aster)]	vigour
[*Arctostaphylos uva-ursi	(kinnikinnick)]	
[Vaccinium caespitosum	(dwarf blueberry)]	
[Geocaulon lividum	(bastard toadflax)]	

Moss Layer: well-developed but species-poor.

Pleurozium schreberi	(red-stemmed feather moss)	)-constant
Ptilium crista-castrensis	(knight's plume feather moss)	)dominant
[Peltigera aphthosa]		

Comments: note that this ecosystem association has little or no Hylocomium splendens, in contrast to the Mesic bunchberry - moss e.a.

SBSel/04(a) SUBMESIC BUNCHBERRY - MOSS, COARSE TEXTURED PHASE

SOILS:

General Description: This phase includes coarse textured soils most commonly found on fluvial and fluvialglacial landforms and occasionally on shallow, coarse, glacial till deposits. Soil development generally consists of a dark yellowish brown Bm (Bfj) to reddish brown Bf horizon which may be overlain by a thin light brownish gray Ae horizon. These mineral horizons have very weakly structured peds. Surface organic horizons are dominated by a moderately decomposed F with common fungal mycelia of various colours. These soils are well-drained and often have relatively deep rooting. The coarse fragment content may vary from a few percent to more than 35% by volume.

Associated Classifications:

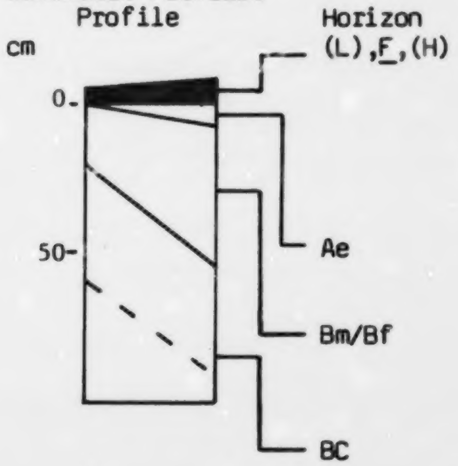
Soil: Orthic and Eluviated Dystric Brunisols; Orthic Humo-Ferric Podzols

Terrain: Fluvial and fluvialglacial blankets; occasionally morainal veneers over bedrock.

Humus Form: Hemimors

Parent Materials: Coarse textured sediments and till

Schematic Profile:



Description

-litter of leaves, needles, and twigs intermixed with mosses over a moderately decomposed, matted F horizon with common fungal mycelia. The H horizon, when present, is well-decomposed plant residues with charcoal common.

-gray; sandy loam; abundant roots of various sizes.

-dark yellowish brown (Bm) to reddish brown (Bf); sandy loam to loam; few to abundant roots.

-yellowish brown; sandy loam to loam; few roots; over fluvial sediments or bedrock.

Key Characteristics:

- coarse textured mineral horizons
- most often fluvial or fluvialglacial deposits
- may be morainal veneer over bedrock

SBSel/04(b) SUBMESIC BUNCHBERRY - MOSS, FINE TEXTURED PHASE

SOILS:

General Description: These soils generally develop on middle to upper slope positions on glacial till deposits. The typical soil profile associated with this phase has a fine textured, subsurface, grayish to dark brown horizon (Bt), overlain by a coarser, reddish brown Bm horizon. A light brownish gray Ae horizon may be above or below the Bm, depending on the stage of genetic development. A moderately decomposed F horizon featuring common to plentiful fungal mycelia is predominant in the surface organic horizons. Root-restricting clay pans and fragipans are common in this phase. These pedons are moderately well-drained.

Associated Classifications:

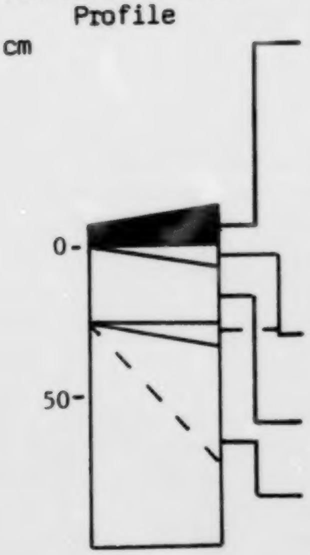
Soil: Orthic and Brunisolic Gray Luvisols

Terrain: Morainal blankets; less commonly morainal veneers over bedrock.

Humus Form: Hemimors

Parent Materials: fine textured glacial till

Schematic Profile:



Horizon	Description
(L),F,(H)	-litter of leaves, needles, and twigs intermixed and lying on top of mosses; with a moderately decomposed F horizon of organic materials, matted, with common to plentiful fungal mycelia, and abundant rooting. The H horizon may be absent or very thin, made up of well-decomposed organic materials with charcoal common.
Ae	-light brownish gray to grayish brown; loam; plentiful to abundant roots.
Bm	-reddish brown; loam to clay loam; plentiful roots.
Bt	-grayish brown to dark brown; clay loam to clay; few roots; clay skins on coarse fragments, in pores and root channels; overlying a Bt-2 or BC horizon.

Key Characteristics:

- glacial till deposits
- finer texture in subsurface horizons

SBSel/04 SUBMESIC BUNCHBERRY - MOSS

The Submesic bunchberry - moss ecosystem association occupies habitats intermediate between the two drier e.a.'s and the mesic or zonal e.a. The SBSel/04 thus represents submesic moisture conditions and submesotrophic to mesotrophic nutrient conditions. Such habitats can result from a variety of factors, such as steep slopes, dry warm aspects, coarse-textured or nutrient-poor soils, and shallow rooting zones. Thus this ecosystem association includes sites with a wide range of slope, aspect, soil texture and nutrient status, in various slope positions and on several different landforms. The Submesic e.a. generally does not cover much of the SBSe landscape, but is much more common and widespread in the drier southern parts of the subzone (i.e., in the southern Morice and Lakes T.S.A.'s).

The vegetation reflects the intermediate, suboptimal growing conditions. Submesic stands are usually well-stocked but overall have relatively poor to moderate growth. Lodgepole pine is usually dominant, but is accompanied by subalpine fir and hybrid white spruce, both of which increase in importance with stand age. Pine generally exhibits fairly good growth (at least for the first few decades of its life), but subalpine fir and spruce both grow poorly.

The shrub layer is poorly to moderately developed and not particularly vigourous. Regenerating subalpine fir are very common, spruce less so. Pine regeneration is rare, in contrast to the drier SBSel/02 and /03. Vaccinium membranaceum and Rosa acicularis are the most characteristic shrubs. Shepherdia canadensis, Alnus viridis, Spiraea betulifolia, and Paxistima myrsinites often occur as well.

Cornus canadensis and Linnaea borealis dominate the generally poorly developed herb layer. Other species with greater than 50% frequency are Epilobium angustifolium, Aster conspicuus, Orthilia secunda, Pyrola chlorantha, Clintonia uniflora, Arnica cordifolia, and Festuca occidentalis. Arctostaphylos uva-ursi, Vaccinium caespitosum, and Geocaulon lividum are sometimes common.

The moss layer is well-developed but species-poor. Pleurozium schreberi is the constant dominant species. Ptilium crista-castrensis and Peltigera aphthosa are very common. Hylocomium splendens is only a minor species, in contrast to its important role in the SBSe1/01.

The SBSe1/04 has two phases based on soil texture:

SBSe1/04(a) Coarse textured phase.

This phase includes coarse textured soils most commonly found on fluvial and fluvialglacial landforms, and occasionally on shallow, coarse deposits of glacial till. Surface organic horizons are dominated by a fungal, moderately decomposed F horizon. Mineral development generally consists of a dark yellowish brown Bm (Bfj) to reddish brown Bf horizon. The coarse fragment content may vary from a few percent to more than 35% by volume. The soils are Orthic and Eluviated Dystric Brunisols and Orthic Humo-Ferric Podzols with Hemimor humus forms. Average pH was 3.6 in the organic horizons and 4.6 in the mineral rooting zone.

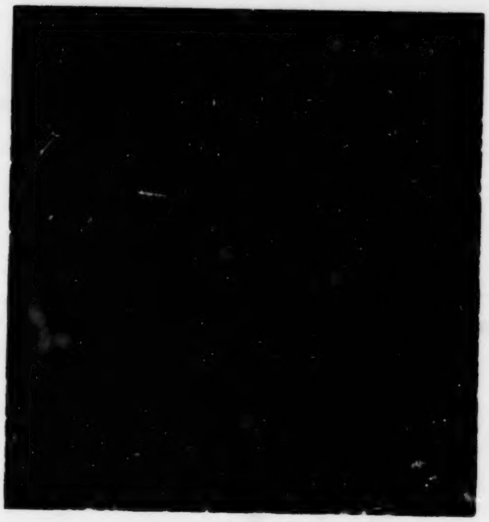
SBSe1/04(b) Fine textured phase.

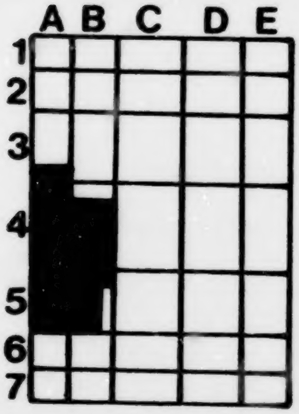
These soils generally develop on middle to upper slope positions on glacial till deposits. A moderately decomposed, fungal F horizon dominates the organic horizons; if a H horizon is present it is well-decomposed with charcoal common. The mineral profile has a fine textured, grayish to dark brown Bt horizon, often overlain by a coarser, reddish brown Bm. An Ae horizon may be above or below the Bm. Root restricting clay pans and fragipans are common in this phase. The soils are Orthic and Brunisolic Gray Luvisols with Hemimor humus forms. Average pH was 3.5 in the organic horizons and 4.6 in the mineral rooting zone.

SBSe1/05 PINE - BLACK SPRUCE

BIOGEOCLIMATIC UNIT: SBSe1

ECOSYSTEM UNIT: SBSe1/05; *Pinus contorta* - *Picea* (*mariana*, *glauca* x *engelmannii*) - *Vaccinium caespitosum* - *Pleurozium schreberi*; Pine - black spruce ecosystem association.





ECOLOGICAL MOISTURE REGIME: Mesic - subhygric

ECOLOGICAL NUTRIENT REGIME: Submesotrophic - oligotrophic

DISTRIBUTION: Scattered in the northern half of the subzone, rarely locally abundant in the study area (much more so further east in the Prince George Region).

PHYSIOGRAPHIC FEATURES:

Slope Positions: On level terrain or gentle lower slopes.

Slope Range: 0 to 5% Aspect: Flat or northerly

Surface Shape: Straight (flat) to slightly concave.

STRATA COVERAGE (%): A: 43 B: 32 C: 61 D: 95

GROUND COVERAGE (%): H: 89 MS: 0 DW: 11 R&S: 0

SBSel/05 PINE - BLACK SPRUCE

VEGETATION:

Tree Layer: trees typically small; densely stocked.

**Pinus contorta*	(lodgepole pine)	-dominates main canopy
Picea mariana	(black spruce)	-forms a sub-canopy
Picea glauca x *engelmannii*	(hybrid white spruce)	-in both main and secondary canopies

Shrub Layer: moderately developed; all low shrubs except for tree regeneration.

Abies lasiocarpa	(subalpine fir)	) -regeneration
P. glauca x *engelmannii*		)
P. mariana		)
Ledum groenlandicum	(Labrador tea)	-good indicator
Vaccinium membranaceum	(black huckleberry)	-poor vigour

Herb Layer: moderately well-developed.

Cornus canadensis	(bunchberry)	
Vaccinium caespitosum	(dwarf blueberry)	) -good
Gaultheria hispidula	(creeping-snowberry)	)
Petasites palmatus	(palmate colt's-foot)	) indicators
Lycopodium annotinum	(stiff club-moss)	
[*Empetrum nigrum*	(crowberry)]	
[*Geocaulon lividum*	(bastard toadflax)]	

Moss Layer: usually a thick carpet of feather mosses.

Pleurozium schreberi	(red-stemmed feather moss)	
Ptilium crista-castrensis	(knight's plume feather moss)	
Peltigera aphthosa		-good vigour
[*Polytrichum* (*commune*/or *juniperinum*)	(hair cap mosses)]	-good vigour
[*Sphagnum girgensohnii*	(sphagnum moss)]	-good indicator if present

Comments: a main canopy of pine with a secondary canopy of black spruce typifies this ecosystem association. Note also the lack or scarcity of *Hylocomium splendens* in the moss layer.

SBSel/05 PINE - BLACK SPRUCE

SOILS:

General Description: Soils associated with this ecosystem association have formed on level to very gently sloping morainal blankets. The organic horizons form a matted surface 5 cm to 10 cm thick, featuring a predominant moderately decomposed F horizon. An eluviated, brownish gray Ae horizon is over either a Bm or Bt subsurface horizon. Bt horizons are usually present and can be recognized by clay skins on peds and coarse fragments. The soil drainage can vary from moderately good to imperfect.

Associated Classifications:

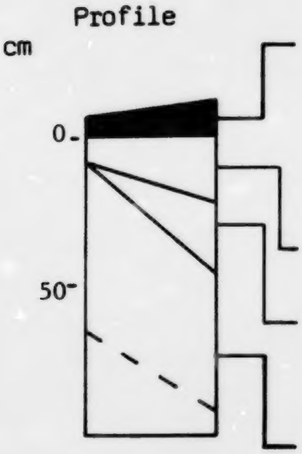
Soil: Orthic and Brunisolic Gray Luvisols; occasionally Orthic Dystric Brunisols

Terrain: Morainal blankets (with occasional fluvial veneer)

Humus Form: Hemimors

Parent Materials: Glacial till

Schematic Profile:



Horizon	Description
(L),F,(H)	-litter of needles, leaves, and branches intermixed with the moss layer; a moderately decomposed, matted F horizon with common fungal mycelia; and at times a thin well decomposed H horizon.
Ae	-brownish gray; sandy loam to loam; weak structure; plentiful roots.
Bm	-dark yellowish brown; loam; weak to moderate, fine, subangular blocky; plentiful roots.
Bt(gj)	-brown to dark brown; sandy clay loam to clay loam; strong coarse, subangular blocky to massive; few roots; overlying a transitional BC or C horizon of original compacted till.

Key Characteristics:

- level to very gently sloping morainal blankets, often bordering wetlands
- restricting, fine textured subsurface horizon(s)

SBSe1/05 PINE - BLACK SPRUCE

Occasionally in our study area we encounter fairly dense but poorly growing forest stands, typically two-tiered, with mostly lodgepole pine in the main canopy and mature black spruce or a combination of black and hybrid white spruce forming a secondary canopy. We have seen no upland stands of pure black spruce in the SBS of the Prince Rupert Region. The pine - black spruce combination is uncommon, but is scattered and sometimes locally abundant in the northern parts of the SBSe. The cover type is much more common further east in the Prince George Region. It seems best to recognize a separate Pine - black spruce ecosystem association, which apparently represents (sub)mesic to subhygric moisture conditions in combination with poor nutrient status, and has a distinctive plant association.

Besides regeneration of both spruces and subalpine fir, *Ledum groenlandicum* and *Vaccinium membranaceum* are common in the poorly to moderately developed shrub layer.

The herb layer is moderately developed. Besides such general species as *Cornus canadensis*, *Petasites palmatus*, and *Lycopodium annotinum*, it typically includes *Vaccinium caespitosum* and *Gaultheria hispidula*, and may also have *Geocaulon lividum* and *Empetrum nigrum*. The latter four species are all good indicators for this ecosystem association.

The moss layer is usually a thick plush carpet of feather mosses, often with significant amounts of vigourous *Peltigera aphthosa* and *Polytrichum commune* or *P. juniperinum.* *Sphagnum girgensohnii* may also occur in wetter depressions.

A similar ecosystem association has been described from the SBS north of Prince George by Revel (1972), and also occurs in the Boreal White and Black Spruce Zone further north (Annas 1977; Harcombe 1978).

The SBSe1/05 occurs on morainal or fluvioglacial landforms, but all sites are very gently sloping or flat. The sites where we have found this ecosystem association all appear to be in areas of cold air ponding, which may account for some of its boreal appearance and affinities.

Soils which we sampled in this e.a. have formed on level to very gently sloping morainal blankets. The organic horizons form a matted surface ca 5 to 10 cm thick, featuring a dominant, moderately decomposed, fungal F horizon. An eluviated, brownish gray Ae horizon overlies either a Bm or Bt subsurface horizon. Soils have been classified as Orthic and Brunisolic Gray Luvisols, and occasionally as Orthic Dystric Brunisols. The common humus form is a Hemimor.

A Bt horizon which may restrict air and water movement and root penetration is usually present. The soils are therefore considered nutrient-poor and drainage can vary from moderately good to imperfect. As well, low soil temperature during the growing season probably plays an important role.

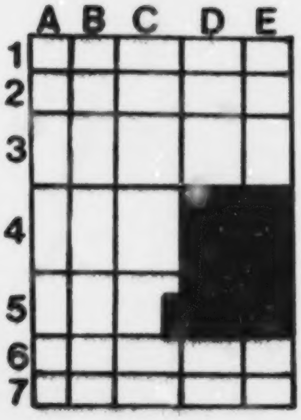
The average pH of the organic horizons was 3.2 while the pH in the mineral rooting zone averaged 4.5.

In the SBS as a whole the Pine - black spruce e.a. is found on soils of various textures, with impeded to moderately good drainage. The better drained soils may be intrinsically poor in nutrients, whereas the more nutrient-rich, finer textured soils often are imperfectly drained, probably poorly oxygenated and cold, and thus effectively reduced in available nutrient supply.

SBSel/06 MOIST THIMBLEBERRY - FORB

BIOGEOCLIMATIC UNIT: SBSel

ECOSYSTEM UNIT: SBSel/06; *Picea glauca* x *engelmannii* - (*Populus tremuloides*) - (*Abies lasiocarpa*) - *Viburnum edule* - *Rubus* (*parviflorus*, *pubescens*); Moist thimbleberry - forb ecosystem association.



ECOLOGICAL MOISTURE REGIME: Mesic - subhygric

ECOLOGICAL NUTRIENT REGIME: Permesotrophic
eutrophic

DISTRIBUTION: Spotty; scattered throughout most of the subzone, but extensive only where prevailing topography steepens (as along major streams and lakes) and presents large expanses of favourable south or west aspects. Seems to be particularly abundant in the western portion of the subzone.

PHYSIOGRAPHIC FEATURES:
Slope Positions: Middle, lower and toe slopes.
Slope Range: 0 to 60%; usually less than 30%

Aspect: Variable but southerly more common.

Surface Shape: Straight to concave.

STRATA COVERAGE (%):	A: 50	B: 60	C: 64	D: 53
GROUND COVERAGE (%):	H: 92	MS: 0	DW: 8	R&S: 0

SBSe1/06 MOIST THIMBLEBERRY - FORB

VEGETATION:

Tree Layer: stands typically fairly open, often with a significant deciduous component.

Picea glauca x engelmannii	(hybrid white spruce)	-good growth
*Populus tremuloides	(trembling aspen)	-good growth
*Pinus contorta	(lodgepole pine)	-good growth
[Abies lasiocarpa	(subalpine fir)]	
[*Populus balsamifera ssp. trichocarpa	(black cottonwood)]	

Shrub Layer: generally well-developed and vigourous.

[P. glauca x engelmannii]		) -regeneration
[A. lasiocarpa]		)
Rubus parviflorus	(thimbleberry)	
Viburnum edule	(highbush-cranberry)	
Lonicera involucrata	(black twinberry)	
Ribes lacustre	(black gooseberry)	
Rosa acicularis	(prickly rose)	
*Cornus sericea	(red-osier dogwood)	

Herb Layer: moderately well-developed; vigourous and diverse.

Rubus pubescens	(trailing raspberry)	-good indicator
Cornus canadensis	(bunchberry)	-abundant and vigourous, but not a good indicator
*Epilobium angustifolium	(fireweed)	
Petasites palmatus	(palmate colt's-foot)	
Arnica cordifolia	(heartleaved arnica)	
Osmorhiza chilensis	(sweetcicely)	
Smilacina racemosa	(false Solomon's-seal)	
*Thalictrum occidentale	(western meadow-rue)	
*Lathyrus nevadensis and/or ochroleucus	(peavines)	
[Actaea rubra]		(baneberry)]

Moss Layer: sparse to moderately developed.

Pleurozium schreberi	(red-stemmed feathermoss)
Ptilium crista-castrensis	(knight's plume feathermoss)
Rhytidiadelphus triquetrus	
[Hylocomium splendens]	(stepped feather moss)]
[Brachythecium spp.]	

Comments: the shrub and herb layers of mature forest in this ecosystem association generally are more diverse and vigourous than those of any other e.a. in the SBSe, except perhaps the Devil's club ecosystem association.

SBSe1/06 MOIST THIMBLEBERRY - FORB

SOILS:

General Description: This ecosystem association has a variety of soil types associated with it and to date has not been differentiated into phases. The soil properties generally indicate a nutrient-rich environment through various and different characteristics. The F horizon is usually friable and contains numerous insect droppings. In addition, the pedon typically has an organic-enriched mineral horizon (Ah). The slope position is usually lower to toe, less frequently mid-slope. Parent materials, landforms, particle size, and texture vary considerably, along with soil classification. Drainage ranges from moderately good to imperfect.

Associated Classifications:

Soil: Orthic Melanic, Sombric, Eluviated, and Dystric Brunisols; Brunisolic Gray Luvisols; and infrequently Humic Luvic Gleysols

Humus Form: Mormoders, Hemimors

Terrain: Morainal, fluvial and colluvial blankets

Parent Materials: Undifferentiated

Schematic Profile: Variability too complex to represent.

Key Characteristics:
- combination of soil properties that indicate active faunal decomposition and intermixing of plant residues
- often lower slope positions receiving periodic nutrient enrichment

Comments: Further sampling may differentiate this association into phases based on soil properties.

SBSel/06 MOIST THIMBLEBERRY - FORB

Many moist rich sites throughout the SBSel are occupied by mixed forest that often has a fair component of deciduous trees, thick shrub and herb layers, and a merely moderately developed moss layer. In many respects it resembles the SBSel/07 or Oak fern ecosystem association. These two e.a.'s occupy similar areas on the edatopic grid, and the Moist thimbleberry - forb e.a. may represent a late-seral phase of the Oak fern e.a. However, the stands we have classified in the SBSel/06 are old enough to be considered climax according to the criteria used in this report, and their average age of 147 years is close to the 158 year age of the stands sampled in the SBSel/07. Furthermore, *Gymnocarpium dryopteris* is rare or lacking in the SBSel/06, whereas it is a constant dominant species of the SBSel/07.

Spruce, pine, subalpine fir (often as regeneration or saplings), and aspen are all common trees of the Moist thimbleberry - forb e.a. Paper birch and cottonwood may also occur. Spruce and subalpine fir dominate the patchy tree regeneration.

Dominant shrubs include *Rubus parviflorus*, *Viburnum edule*, *Lonicera involucrata*, and *Rosa acicularis*; *Ribes lacustre* and *Cornus sericea* are also common.

Epilobium angustifolium, *Osmorhiza chilensis*, *Smilacina racemosa*, *Rubus pubescens*, and *Thalictrum occidentale* characterize the diverse herb layer, which also usually contains a lot of the near-ubiquitous *Cornus canadensis*. *Arnica cordifolia*, *Aster conspicuus*, *Petasites palmatus*, *Linnaea borealis*, *Clintonia uniflora*, and sometimes *Lathyrus nevadensis* are also frequent.

Pleurozium schreberi dominates the patchy moss layer, and is joined by Ptilium crista-castrensis as well as minor Hylocomium splendens, Rhytidiadelphus triquetrus, and species of Brachythecium.

The Moist thimbleberry - forb ecosystem association seems to be best developed in the western, moister portion of the subzone and in those areas of the Nechako Plateau where the topography is more dissected, as along major streams and lakes. Extensive south aspects also seem to favour development of this e.a., perhaps because they promote long-lived seral vegetation. Presumably the warmer microclimate promotes faster decomposition of organic matter, less accumulation of cool, acidic humus, and a richer rooting medium (J. van Barneveld, personal communication).

This e.a. has a variety of associated soils, as reflected in the various soil, terrain, and humus form classifications of sampled plots. Included in the soils are Orthic Melanic, Sombric, Eluviated, and Dystric Brunisols; Brunisolic Gray Luvisols; and infrequently Humic Luvic Gleysols. Morainal, fluvial, and colluvial blankets are included in the landforms, and both Mormoder and Hemimor humus forms are commonly found.

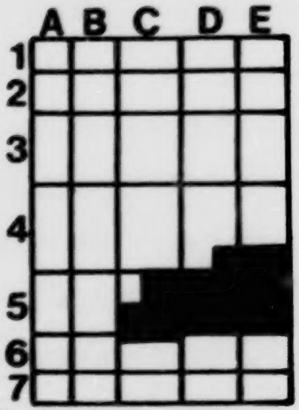
The soil properties generally indicate a nutrient-rich environment. The F horizon, as in the Mormoders, is usually friable and contains numerous insect droppings. In addition, many profiles have an organic-enriched Ah horizon. Drainage ranges from moderately good to imperfect. Ecosystems usually occur on lower or toe slopes, less frequently on the mid-slopes. Further sampling may well differentiate this e.a. into phases based on soil properties.

The average pH of the organic horizons was 4.9, and was 5.4 in the mineral rooting zone.

SBSel/07 OAK FERN

BIOGEOCLIMATIC UNIT: SBSel

ECOSYSTEM UNIT: SBSel/07; *Picea glauca* x *engelmannii* - *Abies lasiocarpa* - *Gymnocarpium dryopteris* - *Pleurozium schreberi* - *Ptilium crista-castrensis*; Oak fern ecosystem association.



ECOLOGICAL MOISTURE REGIME: Subhygric

ECOLOGICAL NUTRIENT REGIME: Mesotrophic - subeutrophic

DISTRIBUTION: Occurs throughout the subzone but is relatively uncommon in the Lakes and southern Morice Timber Supply Areas (i.e., the southern half of the study area).

PHYSIOGRAPHIC FEATURES:
Slope Positions: Usually middle and lower slopes, but can also occur on upper slopes in moister parts of the subzone.
Slope Range: 2 to 60%
Surface Shape: Straight to concave.

Aspect: All

STRATA COVERAGE (%): A: 50 B: 54 C: 73 D: 78

GROUND COVERAGE (%): H: 89 MS: 0 DW: 11 R&S: trace

SBSe1/07 OAK FERN

VEGETATION:

Tree Layer: stands often fairly open; all tree species grow well.

Picea glauca x *engelmannii*	(hybrid white spruce)
Abies lasiocarpa	(subalpine fir)
**Pinus contorta*	(lodgepole pine)

Shrub Layer: moderately developed.

A. lasiocarpa		)	-regeneration
[*P. glauca* x *engelmannii*]		)	
Vaccinium membranaceum	(black huckleberry)		-fairly abundant and vigourous, but not a good indicator
Rubus parviflorus	(thimbleberry)		-sometimes dominant
Ribes lacustre	(black gooseberry)		-good vigour and indicator value
Oplopanax horridus	(devil's club)		-fair vigour
[*Viburnum edule*	(highbush-cranberry)]		
[*Lonicera involucrata*	(black twinberry)]		
[*Alnus viridis*	(Sitka or green alder)]		

Herb Layer: moderately well-developed.

Gymnocarpium dryopteris	(oak fern)		-usually dominant and vigourous
Cornus canadensis	(bunchberry)	)	-abundant and vigourous, but not good indicators
Rubus pedatus	(five-leaved bramble)	)	
Tiarella trifoliata	(three-leaved foamflower)	)	-good indicators if present
[*Streptopus amplexifolius*	(clasping-leaved twisted-stalk)]	)	
[*Orthilia secunda*	(one-sided wintergreen)]	)	-frequent but patchy; not good indicators
[*Lycopodium annotinum*	(stiff club-moss)]	)	
[*Linnaea borealis*	(twinflower)]	)	
[*Arnica cordifolia*	(heartleaved arnica)]	)	

Moss Layer: moderately well-developed; cover often discontinuous.

Pleurozium schreberi	(red-stemmed feather moss)		
Ptilium crista-castrensis	(knight's plume feather moss)		
Barbilophozia lycopodioides			
Mnium insigne		)	-other species of *Mnium* and *Brachythecium* frequently occur as well
Brachythecium hylotapetum		)	
[*Hylocomium splendens*	(stepped feather moss)]		

SBSe1/07(a) OAK FERN, COARSE TEXTURED PHASE

SOILS:

General Description: The soils associated with this phase are coarse textured morainal, or colluvial over morainal deposits. Consequently, these soils are better drained than the fine textured phase, generally moderately well to well. A restrictive horizon (either a water table or compacted till) is usually present between 30 cm to 80 cm. The surface organic horizons average 10 cm in thickness but the nature of the fabric and mode of decomposition are variable. The surface mineral horizons may include an eluviated Ae horizon over one or a series of Bm and Bf horizons. Unaltered parent materials are usually within one meter of the surface.

Associated Classifications:

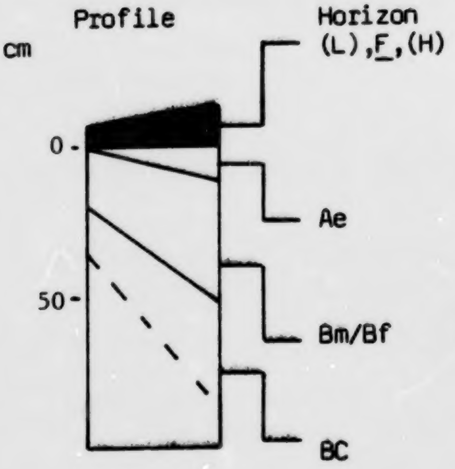
Soil: Orthic Humo-Ferric Podzols;
Orthic Dystric Brunisols

Terrain: Morainal blankets,
colluvial veneers over
morainal blankets

Humus Form: Mormoder
(Hemimor)

Parent Materials: Coarse
textured tills and
colluvium

Schematic Profile:



Description

-litter is loose and often mixed with bryophytes. The F horizon is dominant and may be friable or matted. A well-decomposed H horizon may or may not be present. Common to plentiful roots.

-light brownish gray; loamy sand to sandy loam; weak subangular blocky; plentiful roots.

-yellowish to strong brown; loamy sand, sandy loam or loam; weak subangular blocky; plentiful roots.

-dark grayish brown; loam to sandy clay loam; very weak to structureless; very few roots; over compacted till and periodic perched water tables.

Key Characteristics:

- coarse textured surface mineral horizons
- parent material often a compacted till
- moderately well- to well-drained in rooting zone

SBSel/07(b) OAK FERN, FINE TEXTURED PHASE

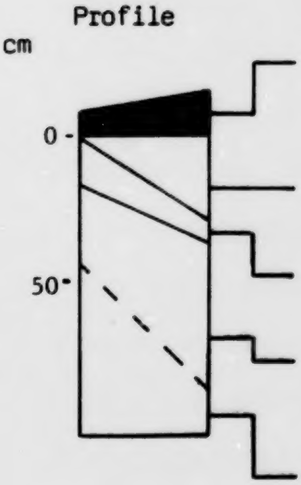
SOILS:

General Description: Soils in this phase have developed on fine morainal blankets in the middle and lower slope positions on less than 10% gradients. They are imperfectly drained and may have periodic seepage. All sites sampled had restrictive layers between 45 cm and 80 cm, atop either a perched water table or compact till. The fabric and mode of decomposition in the organic horizons are variable; however, there is a trend toward moder development. A dark coloured Ah horizon may be present followed by an eluviated Ae overlying a Bm or transitional AB horizon. A clay-enriched Bt(g) horizon shows clay skins on peds and/or coarse fragments and may be mottled.

Associated Classifications:

Soil: Dark, Gleyed Brunisolic, and Brunisolic Gray Luvisols	Terrain: Morainal blankets
Humus Form: Mormoder, Leptomoder, Hemimor	Parent Materials: Glacial till

Schematic Profile:



Horizon	Description
(L),F,H	-litter is loose and often intermixed with bryophytes. The F horizon may be friable or matted and there is often a well-decomposed H horizon.
(Ah)	-very dark brown; loam to clay loam; granular; plentiful roots.
Ae	-dark grayish brown; loam; weak platy structure; few roots.
Bm/AB	-dark brown; silt loam to clay loam; moderate subangular blocky; plentiful roots.
Bt(g)	-dark to dark yellowish brown; sandy clay loam to clay loam; faint yellowish brown mottles; moderate subangular blocky; few roots; clay skins on peds and/or coarse fragments; overlying a BC or C horizon of fine glacial till.

Key Characteristics:
- fine morainal blankets
- Bt(g) horizon with clay skins and possible mottles
- trend toward moder development and intermixing of organic matter with mineral soil (Ah)
- imperfect drainage

SBSe1/07 OAK FERN

The Oak fern ecosystem association is best developed in subhygric/ mesotrophic or richer habitats. It may also occur on cool north slopes that have less favourable moisture and nutrient regimes but also have deeper humus and colder, more acidic soils than comparable south slopes (J. van Barneveld, personal communication). Tree growth is generally good to excellent. Hybrid white spruce and subalpine fir dominate the tree layer. Lodgepole pine is common but trembling aspen and paper birch occur only occasionally. Stands are often fairly open; some are understocked.

Subalpine fir regeneration is common in the moderately developed shrub layer. Young spruce are less common and often become established on decaying wood beneath openings in the forest canopy. Vaccinium membranaceum is a constant and often fairly abundant shrub, but better indicators of the site are Rubus parviflorus and Ribes lacustre. Also common but not abundant are Oplopanax horridus, Viburnum edule, Lonicera involucrata, and Alnus viridis.

The herb layer is moderately well-developed. Gymnocarpium dryopteris is usually dominant and vigourous. Tiarella trifoliata and Streptopus amplexifolius are common and good indicators of moist rich conditions. In contrast, both Cornus canadensis and Rubus pedatus are constant and often abundant, but indicate the habitat more by their vigour than their presence.

Orthilia secunda, *Lycopodium annotinum*, *Linnaea borealis*, and *Arnica cordifolia* are all frequent but patchy, and similarly not good indicators.

The moss layer is moderately well-developed, with an often discontinuous cover in response to variable canopy cover of the upper vegetation layers. *Pleurozium schreberi* and *Ptilium crista-castrensis* codominate. *Barbilophozia lycopodioides*, *Mnium insigne*, *Brachythecium hylotapetum*, and *Hylocomium splendens* are common. Other species of *Mnium* and *Brachythecium* frequently occur as well.

The Oak fern ecosystem association occurs throughout the SBSe. However, like the Devil's club e.a. but in contrast to the Submesic bunchberry - moss e.a., it is widespread in the northern part of the subzone and relatively uncommon in the Lakes and southern Morice T.S.A.'s. Slope positions are usually middle and lower, but in moister parts of the subzone the Oak fern e.a. can also occur on upper slopes.

There are two phases in the Oak fern e.a.; the coarse and fine textured phases.

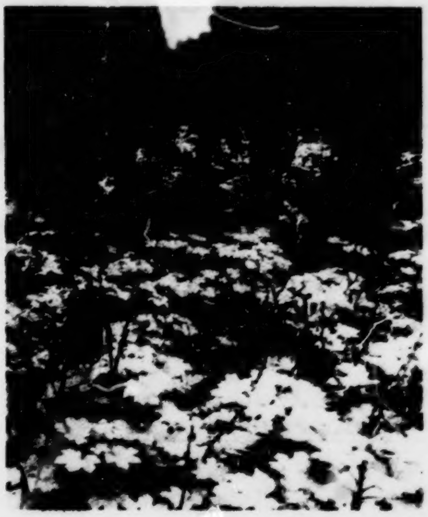
In the coarse textured phase, (SBSe1/07(a)) Orthic Humo-Ferric Podzols and Orthic Dystric Brunisols develop on morainal blankets or on colluvial veneers over the same. Mormoder humus forms are common; however, Hemimors also occur. Because of the coarse nature of these soils, they are moderately well to well-drained. The dominant F horizon in the organic layer may be friable or, less frequently, matted. A Bm or Bf horizon may be overlain by an Ae and unaltered parent materials are usually within 1 m of the surface. The glacial till is often compacted and restrictive, and sometimes supports a seasonally perched water table. The average pH of the organic horizons was 3.9; that of the mineral rooting zone was 4.6.

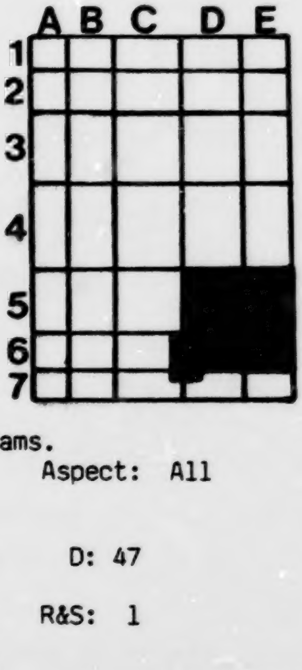
Soils in the fine textured phase (SBSel/07(b)) have developed on fine textured morainal blankets, on gentle middle and lower slopes. They are imperfectly drained and may have periodic seepage. The soils are Luvisols of Dark Gray, Gleyed Brunisolic, and Brunisolic Gray subgroups. The humus forms described in the sample plots were Mormoders, Leptomoders, and Hemimors. Ah horizons occur more frequently in this phase, and are underlain by an Ae. A Bm or AB horizon commonly overlies the Bt, which may be mottled (Btg). The pH was 4.0 in the organic horizons and 4.5 in the mineral rooting zone.

SBSel/08 DEVIL'S CLUB

BIOGEOCLIMATIC UNIT: SBSel

ECOSYSTEM UNIT: SBSel/08; *Abies lasiocarpa* - *Picea glauca* x *engelmannii* - *Oplopanax horridus* - *Gymnocarpium dryopteris*; Devil's club ecosystem association.





ECOLOGICAL MOISTURE REGIME: Subhygric - hygric

ECOLOGICAL NUTRIENT REGIME: Permesotrophic - eutrophic

DISTRIBUTION: Occurs throughout the subzone; patchy in distribution over subdued plateau terrain, more widespread and better developed in mountainous regions (i.e., northern and western portions of the study area).

PHYSIOGRAPHIC FEATURES:

Slope Positions: Almost always on lower or toe slopes; slope bases, in gullies, along streams.

Slope Range: 2 to 55%, usually less than 30%. Aspect: All

Surface Shape: Straight to concave.

STRATA COVERAGE (%): A: 43 B: 73 C: 56 D: 47

GROUND COVERAGE (%): H: 93 MS: 0 DW: 6 R&S: 1

SBSe1/08 DEVIL'S CLUB

VEGETATION:

Tree Layer: trees usually large but widely spaced.

Picea glauca x engelmannii	(hybrid white spruce)	-excellent growth
Abies lasiocarpa	(subalpine fir)	-good growth

Shrub Layer: well-developed and vigourous, with both tall and low shrubs.

A. lasiocarpa	)	-regeneration
[P. glauca x engelmannii]	)	
Oplopanax horridus	(devil's club)	-characteristic dominant; good vigour
Rubus parviflorus	(thimbleberry)	
Ribes lacustre	(black gooseberry)	
[Lonicera involucrata	(black twinberry)]	
[*Alnus viridis	(Sitka or green alder)]	-sometimes abundant

Herb Layer: moderately developed; patchy but diverse and vigourous.

Gymnocarpium dryopteris	(oak fern)	-usually abundant and vigourous
Cornus canadensis	(bunchberry))	-common but localized on higher microsites; not good indicators
Rubus pedatus	(five-leaved bramble))	
Streptopus amplexifolius	(clasping-leaved twistedstalk))	-good indicators
[Galium triflorum	(creeping sweet bedstraw)])	
[Tiarella trifoliata	(three-leaved foamflower)])	

Moss Layer: poorly to moderately developed; patchy.

Mnium spp.	)	-good indicators
Brachythecium spp.	)	
Pleurozium schreberi	(red-stemmed feather moss))	-feather mosses are frequent but not abundant, localized on higher microsites; not good indicators
Ptilium crista-castrensis	(knight's plume feather moss))	
[Hylocomium splendens	(stepped feather moss)])	
[Barbilophozia lycopodioides]		

SBSel/08(a) DEVIL'S CLUB, COARSE TEXTURED PHASE

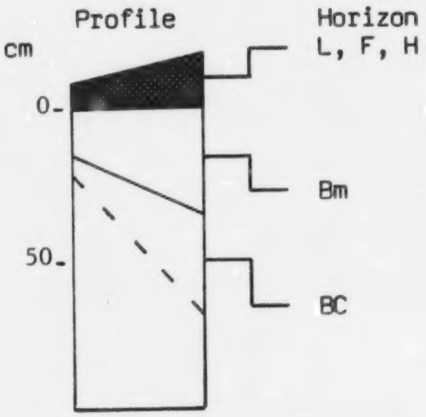
SOILS:

General Description: This phase occurs on fluvial and glacialfluvial fans and terraces, with seepage occurring periodically at depth. The organic horizons are ca 10 cm thick but vary in decomposition and fabric. The mineral soil is coarse textured and often skeletal. A reddish to dark grayish brown Bm horizon overlies a BC or C horizon lighter in colour or variegated, with little or no evidence of soil development. These pedons are rapidly to well-drained on toe or lower slopes.

Associated Classifications:

Soil: Orthic Dystric and Eutric Brunisols	Terrain: Fluvial fans; fluvial-glacial terraces
Humus Form: Hemimor, Humimor, Mormoder	Parent Materials: Fluvial sediments

Schematic Profile:



Horizon	Description
L, F, H	-leafy litter on moderately and well-decomposed F and H horizons; fabric variable; common to abundant rooting.
Bm	-reddish to dark grayish brown; loam to sandy loam; weak structure; plentiful to abundant roots.
BC	-dark grayish brown to variegated; sandy; few to plentiful roots; over a C or series of C horizons that may vary in colour and texture.

Key Characteristics:

- fluvial and fluvialglacial fans and terraces
- periodic seepage at depth
- toe and lower slopes, often adjacent to streams and rivers

SBSel/08(b) DEVIL'S CLUB, FINE TEXTURED PHASE

SOILS:

General Description: This phase occurs on morainal deposits that have root-restricting layers (at 20 - 80 cm); either as a fine textured horizon, compact parent materials, or a perched water table that is likely influenced by texture or compaction. The phase develops on middle to toe slope positions and seepage may occur periodically. Profiles vary in texture but trend towards the finer textures. The pedons are moderately well to imperfectly drained.

Associated Classifications:

Soil: Orthic, Gleyed Dark, Dark, and Brunisolic Gray Luvisols; Orthic Humic Podzols; Orthic Gleysols; and Orthic Eutric Brunisols

Terrain: Morainal blankets

Humus Form: Hemimor, Humimor, Mormoder

Parent Materials: Glacial till

Schematic Profile: Variability too complex to represent.

Key Characteristics:

- moderately well to imperfectly drained
- morainal blankets (trend toward finer textures)
- restrictive layers, causing perched water tables periodically
- intermittent seepage or moisture at or near the surface

SBSel/08 DEVIL'S CLUB

The Devil's club ecosystem association occurs on moist, nutritionally rich sites, generally under moister and richer conditions than any of the preceding ecosystem associations in the SBSel. The coarse textured phase has a complex moisture/nutrient regime in which the upper part of the soil is rarely wet and often not much enriched, but the lower part transmits excess, nutrient-enriched moisture. The fine textured phase is moist and rich to the surface. The favourable habitat is reflected in excellent tree growth, as well as general vegetation structure and floristic make-up.

Hybrid white spruce and subalpine fir are the predominant trees, and both show good to excellent growth --- on average the best for both these species in the subzone. Lodgepole pine occurs only occasionally in mature stands, but it too grows very well. Although individual trees are large, stands of this e.a. are usually understocked, probably because of competition from herbs and shrubs during the seral stages. Trees are widely spaced and the canopy is often irregularly open.

A fairly open tree canopy and moist rich habitat result in a well-developed, vigourous shrub layer, with both tall and low shrubs. Subalpine fir dominates tree regeneration, but spruce is common as well. Oplopanax horridus is the constant dominant shrub; other characteristic species are Rubus parviflorus, Ribes lacustre, and Lonicera involucrata. Alnus viridis may also be abundant.

The herb layer is not very well-developed because the dense shrub layer does not allow much light to reach the ground. Hence herb cover is patchy, but still diverse and vigourous. Gymnocarpium dryopteris is usually abundant and vigourous. Streptopus amplexifolius, Galium triflorum, and Tiarella trifoliata have high frequency but relatively low cover. Cornus canadensis and Rubus pedatus are both common and vigourous, but tend to be localized on higher microsites, and are not particularly indicative of the favourable habitat.

The moss layer is, like the herb layer, poorly to moderately developed and patchy. Various species of Mnium (M. medium, M. insigne, M. glabrescens) and Brachythecium (B. salebrosum, B. hylotapetum, B. rutabulum) are common and good indicators. Feather mosses are frequent but not abundant, and localized on higher microsites.

The Devil's club e.a. occurs throughout the SBSel, but is patchy in distribution over subdued plateau terrain, as in the southern and southeastern portions of the subzone. The SBSel/08 develops on or at the base of long, steep slopes, in ravines and gullies, and along streams, and is thus more widespread and better developed in the foothills of mountainous regions, as in the northern and western portions of the subzone.

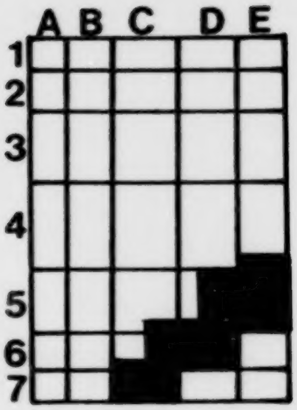
The Devil's Club e.a. has coarse textured and fine textured phases. The coarse textured phase (SBSel/08(a)) occurs on fluvial and fluvialglacial fans and terraces, in toe and lower slope positions, often adjacent to streams and rivers. The organic horizons are ca 10 cm thick and vary in degree of decomposition and type of 'fabric'. A reddish to dark grayish brown Bm horizon is always present over a BC(g), C(g), or series of C horizons. The pedons are well to rapidly drained. Soils have been classified as Orthic Dystric and Eutric Brunisols; humus forms as Hemimors, Humimors, and Mormoders.

The fine textured phase (SBSel/08(b)) occurs on morainal deposits in middle to toe slope positions. Compact parent materials or fine textured subsurface horizons are restricting and may cause seasonally perched water tables. The pedons are moderately well to imperfectly drained. As in the coarse textured phase, the humus forms were Hemimors, Humimors, and Mormoders. The soils show a wider range in classification, including Luvisols, Brunisols, Podzols and at times, Gleysols. The average pH's were 4.8 and 5.7 for the organic layers and mineral rooting zone, respectively.

SBSel/09 HORSETAIL FLAT

BIOGEOCLIMATIC UNIT: SBSel

ECOSYSTEM UNIT: SBSel/09; *Picea glauca* x *engelmannii* - (*Abies lasiocarpa*) - *Lonicera involucrata* - *Equisetum* (*arvense*, *sylvaticum*, *pratense*); Horsetail flat ecosystem association.



ECOLOGICAL MOISTURE REGIME: Subhygric - subhydric

ECOLOGICAL NUTRIENT REGIME: Mesotrophic - eutrophic

DISTRIBUTION: Common throughout the subzone but rarely extensive; occurs in moisture-receiving *positions* in depressions and draws, along streams, and around lakes and wetlands.

PHYSIOGRAPHIC FEATURES:

Slope Positions: Toe slopes, depressions, and level valley bottoms.

Slope Range: 0 to 10%, usually flat. Aspect: Usually on the flat.

Surface Shape: Straight (level) to concave.

STRATA COVERAGE (%):	A: 51	B: 48	C: 83	D: 67
GROUND COVERAGE (%):	H: 88	MS: trace	DW: 12	R&S: trace

SBSe1/09 HORSETAIL FLAT

VEGETATION:

Tree Layer: mature trees large but widely spaced.

Picea glauca x engelmannii	(hybrid white spruce)	-excellent growth
Abies lasiocarpa	(subalpine fir)	
[*Pinus contorta	(lodgepole pine)]	

Shrub Layer: moderately developed, with both tall and low shrubs.

A. lasiocarpa		-regeneration
[P. glauca x engelmannii]		
Lonicera involucrata	(black twinberry)	
Ribes lacustre	(black gooseberry)	
*Alnus incana	(speckled alder)	
[Viburnum edule	(highbush-cranberry)]	

Herb Layer: well-developed, vigourous.

Equisetum arvense	(common horsetail)	-characteristic dominants, individually or in combination
Equisetum sylvaticum	(wood horsetail)	
[Equisetum pratense	(meadow horsetail)]	
Rubus pubescens	(trailing raspberry)	
Gymnocarpium dryopteris	(oak fern)	
Cornus canadensis	(bunchberry)	-localized on higher microsites; not good indicators
Rubus pedatus	(five-leaved bramble)	
Streptopus amplexifolius	(clasping-leaved, twistedstalk)	-frequent but not abundant; good indicators
Mitella nuda	(creeping mitrewort)	
[*Sanguisorba canadensis ssp. latifolia	(Sitka burnet)]	-sometimes common

Moss Layer: poorly to moderately developed; patchy.

Mnium spp.		-characteristic species
Pleurozium schreberi	(red-stemmed feather moss)	-common but not a good indicator
[Brachythecium spp.]		

SBSel/09(a) HORSETAIL FLAT, COARSE TEXTURED PHASE

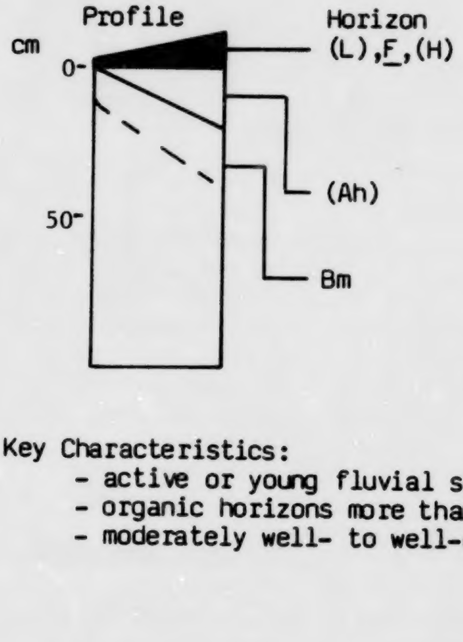
SOILS:

General Description: This phase includes soils developed on active or relatively young fluvial terraces and floodplains. A water table is not evident in the upper 1 meter of the profile; soils are moderately well- to well-drained. The organic accumulation is less than 10 cm and the mineral horizons indicate sedimentation layers through textural changes. The texture trends toward sand and sandy loams; however, finer textured horizons may occur.

Associated Classifications:

Soil: Orthic Dystric Brunisols and Cumulic Regosols	Terrain: Fluvial blankets
Humus Form: Leptomoder, Mormoder, (Rhizomull)	Parent Materials: Fluvial sediments

Schematic Profile:



Description

-comprised mostly of moderately decomposed, friable plant residues, commonly with insect droppings. May have a well-decomposed H horizon.

-dark brown; sandy loam to loam; weak granular; plentiful roots.

-brown to yellowish brown; coarse to medium textured; weak subangular blocky; with plentiful roots over a series of sediments that vary in texture, coarse fragments, and colour.

Key Characteristics:

- active or young fluvial sediments
- organic horizons more than 10 cm thick
- moderately well- to well-drained

SBSel/09(b) HORSETAIL FLAT, FINE TEXTURED PHASE

SOILS:

General Description: This phase represents soils that have similar properties of poor drainage, slow permeability, shallow depth to water table and effective rooting, thick organic horizons, finer textures, and toe and depressional slope positions. The effective rooting depths average close to 20 cm, which probably also represents the average depth to the water table which will vary seasonally. The thickness of the sampled organic horizons ranges from 18-47 cm. The mineral horizons may have a dark organic-enriched surface (Ah) horizon, followed by a gleyed Bg or Cg, poorly drained subsurface horizon. However, the organic horizons may lie directly on a Cg horizon with no mineral surface horizon development.

Associated Classifications:

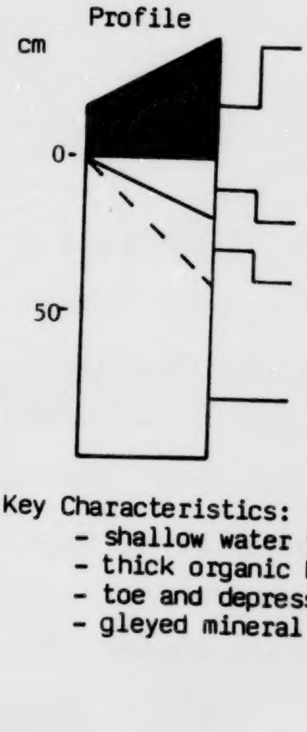
Soil: Orthic Humic, Orthic, and Rego Gleysols

Humus Form: Hydromoder, Hydromor, (Histomoder)

Terrain: Morainal and lacustrine blankets

Parent Materials: Glacial till and lacustrine sediments

Schematic Profile:



Horizon	Description
(L),F,H,(Om)	-scattered litter on compacted F and H horizons with plentiful roots. An Om horizon that is saturated and with very few roots may lie between these and the mineral interface.
(Ah)	-black; loam; granular; plentiful roots.
Bg	-very dark gray to grayish brown; sandy loam to sandy clay loam; may be mottled; massive; few to no roots.
Cg	-dark olive gray; sandy clay loam; massive; no roots.

Key Characteristics:
- shallow water table, poor drainage
- thick organic horizons
- toe and depressional slope positions
- gleyed mineral horizons

SBSel/09 HORSETAIL FLAT

Whereas the SBSel/08 or Devil's club ecosystem association most often occurs on sloping terrain, the SBSel/09 or Horsetail flat e.a. develops on flat or gently sloping sites, often on fluvial landforms but also in depressions or on toe slopes in lacustrine and morainal landscapes. The SBSel/08 and /09 overlap somewhat in moisture and nutrient conditions, but the Horsetail e.a. tends to occur on wetter and also less rich sites. There is also a trend towards poorer drainage in horsetail ecosystems, except on fluvial landforms. On fluvial terraces this ecosystem association is analogous to the Cottonwood e.a. of the SBSd, but cottonwood is not usually a significant component of mature stands, and extensive stands of alluvial cottonwood are uncommon in our SBSe.

SBSel/09 stands are often understocked, with large but widely spaced trees, and irregular canopies dominated by hybrid white spruce and subalpine fir. Lodgepole pine occurs occasionally. Spruce growth is excellent; subalpine fir and pine grow well but generally not as well as in the Devil's club e.a.

Despite the fairly open tree canopy, the shrub layer is only moderately developed, but includes both tall and low shrubs. There is regeneration of both subalpine fir and spruce. *Lonicera involucrata*, *Ribes lacustre*, and *Alnus incana* are the most characteristic shrubs; *Viburnum edule* is also common.

The herb layer is well-developed, fairly continuous, diverse and vigourous. Species of horsetails (*Equisetum arvense*, *E. sylvaticum*, and *E. pratense*) are characteristic dominants, individually or in combination. *Gymnocarpium dryopteris* and *Rubus pubescens* are also common and abundant.

Other frequent species include Streptopus amplexifolius and Mitella nuda, as well as the near-ubiquitous Cornus canadensis and Rubus pedatus.

The upper vegetation strata cast sufficient shade on the ground, and rates of decomposition of surface organic material are sufficiently rapid, that the moss layer is merely poorly to moderately developed, and typically patchy.Species of Mnium are characteristic, and Aulacomnium palustre and Brachythecium spp. may be frequent. Pleurozium schreberi and Ptilium crista-castrensis are still common but not abundant, and indicate drier microsites rather than the prevailing habitat conditions.

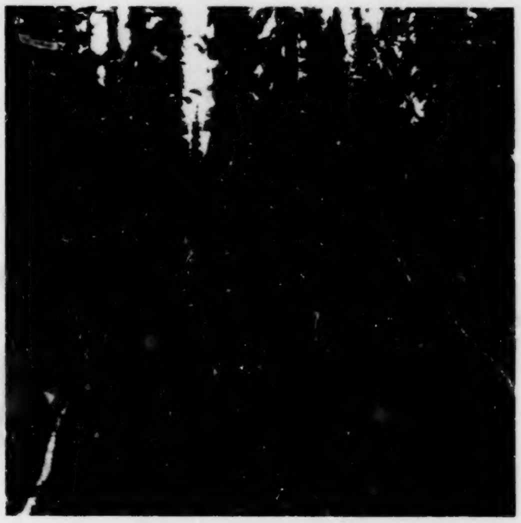
There are both coarse textured and fine textured phases in this e.a. The coarse textured phase (SBSel/09(a)) includes soils developed on active or relatively young fluvial terraces and floodplains. In contrast to the fine textured phase, the coarse textured phase is moderately well- to well-drained and the organic horizons are less than 10 cm thick. Mineral horizons vary in texture but are almost always coarse; e.g., sand, sandy loam, etc. These horizons are layered due to sedimentation processes: coarse fragment content varies with colour from layer to layer. Often an Ah horizon is at the top of the mineral profile followed by a brownish Bm. The organic horizons have a dominant, friable F which, in combination with other horizons, may give rise to Leptomoder, Mormoder, and at times Rhizomull humus forms. Both the organic and mineral pH values averaged 4.7.

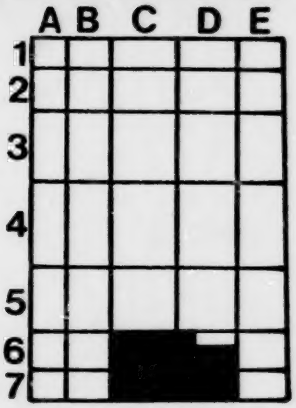
The fine textured phase (SBSel/09(b)) not only has finer textures, but also represents soils that have similar properties of poor drainage, slow permeability, shallow depth to water table and effective rooting, and thick organic horizons (ca 20 cm). These soils occur on lacustrine and morainal blankets. The poor drainage is reflected in the organic horizons by slower decomposition and gradual accumulation. These horizons are thought to be poorly aerated due to prolonged or permanent saturation. The humus forms were classified as Hydromoders, Hydromors and, at times, Histomoders. The mineral horizons may have a dark, organic-enriched Ah surface horizon, followed by a poorly drained, gleyed Bg or Cg horizon. The soils were classified as Gleysols of Orthic, Orthic Humic, and Rego subgroups. The average pH of the organic layers was 4.7; that of the mineral rooting zone was 5.7.

SBSel/10 BLACK SPRUCE FEN AND SWAMP

BIOGEOCLIMATIC UNIT: SBSel

ECOSYSTEM UNIT: SBSel/10; *Picea mariana* - *Salix* (*barclayi*, *glauca*) - *Betula glandulosa* - *Carex* (*aquatilis*, *disperma*) - *Sphagnum capillaceum* - *Tomenthypnum nitens*; Black spruce fen and swamp ecosystems.





ECOLOGICAL MOISTURE REGIME: Hygric - sybhydric

ECOLOGICAL NUTRIENT REGIME: Mesotrophic - permesotrophic

DISTRIBUTION: Scattered throughout the subzone but rarely extensive; most common on northern Nechako Plateau.

PHYSIOGRAPHIC FEATURES:
Slope Positions: Level and depressional.
Slope Range: 0 (level) Aspect: Not applicable.
Surface Shape: Straight (flat) but often hummocky.

STRATA COVERAGE (%): A: 15 B: 50 C: 59 D: 80

GROUND COVERAGE (%): H: 97 MS: 0 DW: 2 R&S: 0

SBSel/10 BLACK SPRUCE FEN and SWAMP

VEGETATION:

Tree Layer: sparse to poorly developed; trees tend to be clumped.

Picea mariana	(black spruce)	-usually poorly growing
[Picea glauca x engelmannii	(hybrid white spruce)]	-sometimes has fairly good growth

Shrub Layer: moderately to well-developed.

P. mariana		-regeneration and stunted mature individuals
Salix barclayi	(Barclay's willow)	) -characteristic
Salix glauca	(gray-leaved willow)	) dominants
Salix drummondiana	(Drummond's willow)	
Betula glandulosa	(scrub birch)	
[Ledum groenlandicum	(Labrador tea)]	
[Alnus incana	(speckled alder)]	) -sometimes
[Spiraea douglasii	(hardhack)]	) abundant

Herb Layer: moderately well-developed, diverse; dominated by sedges.

Carex aquatilis	(water sedge)	-characteristic dominant
Carex disperma	(soft-leaved sedge)	
Calamagrostis canadensis	(bluejoint)	
[Rubus chamaemorus	(cloudberry)]	) -frequent but
[Gaultheria hispidula	(creeping-snowberry)]	) not abundant;
[Vaccinium oxycoccos	(bog cranberry)]	) good indicators

Moss Layer: moderately well-developed.

Sphagnum capillaceum	(sphagnum or peat moss)	-characteristic dominant; other species of Sphagnum also common
Tomenthypnum nitens		
Aulacomnium palustre		
[Mnium spp.]		
[Drepanocladus spp.]		
[Calliergon spp.]		

Comments: black spruce wetlands have distinctive, unmistakable vegetation and are easily recognized.

SBSel/10 BLACK SPRUCE FEN AND SWAMP

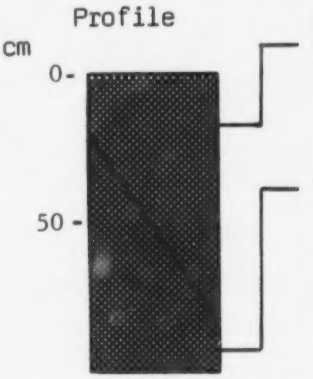
SOILS:

General Description: The soils associated with these ecosystems are organic blankets on very poorly drained level or depressional landscapes. The underlying mineral materials have not been studied. The upper horizons show very little decomposition (Of) and this may continue deep into the profile. Sampling has been very limited.

Associated Classifications:

Soil: Fibrisols and Mesisols	Terrain: Organic blankets
Humus Form: Histomors	Parent Materials: Plant residues

Schematic Profile:



Horizon	Description
Of	-plant residues show very little evidence of decomposition and botanical origins are usually readily identifiable.
Om	-plant residues that are moderately decomposed.

Key Characteristics:

- poorly drained organic blankets

SBSe1/10 BLACK SPRUCE FEN and SWAMP

The wetlands of the SBSe in the Prince Rupert Forest Region are usually minerotrophic types; that is, marshes, fens, and swamps. We have not sampled any marshes, but have investigated several fens and swamps. As in the SBSd, the vegetation of these ecosystems is too variable to group into a single plant association, but the wetlands we have sampled are closely related and for our purposes can be treated together as Black spruce fen and swamp ecosystems.

Wetlands are scattered throughout the subzone but are only occasionally extensive, and are most common on the northern Nechako Plateau. They occur in very poorly drained level and depressional sites, and have hygric to subhydric moisture status and mesotrophic to richer nutrient status. Although levels of cations are high, the organic soils are waterlogged and their nutrients are not readily available to trees.

Black spruce is the predominant tree in those wetlands that have trees, but hybrid white spruce may also occur. The trees are usually growing poorly and do not form a closed canopy.

The shrub layer is moderately to well-developed and includes regenerating and stunted mature black spruce, as well as abundant willows (Salix barclayi, S. glauca, and S. drummondiana, typically) and Betula glandulosa. Ledum groenlandicum is a constant species, and Alnus incana and Spiraea douglasii are sometimes abundant.

Sedges dominate the moderately well-developed herb layer. Carex aquatilis is a constant dominant; Carex disperma is also constant but usually not as abundant. Calamagrostis canadensis is another typical species, as are the frequent but less abundant *Rubus chamaemorus*, *Gaultheria hispidula*, and *Vaccinium oxycoccos*.

The well-developed moss layer is dominated by *Sphagnum capillaceum*; other species of *Sphagnum* are also common. *Tomenthypnum nitens* and *Aulacomnium palustre* are frequent and indicative of minerotrophic conditions, as are the less frequent *Drepanocladus exannulatus*, *D. uncinatus*, *Calliergon cordifolium*, *C. stramineum*, and *Mnium* spp.

The soils associated with these wetland ecosystems are organic blankets on very poorly drained, level or depressional landscapes. The underlying mineral materials have not been studied. The upper horizons (Of) show very little decomposition; the lack of decomposition may continue deep into the profile. The two soils sampled were classified as a Fibrisol and a Mesisol. The humus forms were both Histomors. Values of the pH in the upper 40 cm of the profile averaged 5.2.

9.0 SILVICULTURAL MANAGEMENT INTERPRETATIONS

9.1 Introduction

Ecological classification in British Columbia provides silviculturists with a systematic framework for collecting and organizing knowledge that can be used to develop silvicultural prescriptions. The classification aids the silviculturist in managing forest ecosystems for optimum forest productivity.

It is important to understand how we developed the silvicultural prescriptions in this guide and how they should be interpreted. Without this information the user may question why a particular treatment or sequence of treatments is recommended. Three primary sources of information went into developing silvicultural prescriptions for an ecosystem: (1) silvicultural and environmental limitations of an ecosystem; (2) results of previous practices on the ecosystem; and (3) a review of the relevant literature.

Environmental limitations are the properties of an ecosystem that limit treatment options. Silvicultural limitations of tree species also limit treatment options (see Geisler et al. 1982 for further information on silvics of tree species in the Prince Rupert Forest Region). These parameters often determine treatments. Regarding species choice, for example, the available moisture in an ecosystem may be adequate for one species while inadequate for another. Another example of a limitation would be the necessity of using plugs when planting on extremely rocky soils.

In examining past silvicultural practices we asked: (1) have they significantly altered the site, and (2) are the established species the ones best suited for the treated ecosystem? The answers to these questions are often neither easy nor straightforward. But they must be addressed when silvicultural prescriptions are made on an ecosystem basis.

The silvicultural prescriptions do not take into account what we call other stand management considerations. These stand management considerations include fish and wildlife, protection, range, agriculture, land alienation, administration and planning, engineering, annual allowable cuts, and aesthetics. A silvicultural prescription in this guide simply outlines the treatments considered to be best suited silviculturally to the site, given our present state of knowledge of the SBS. Once the user has decided on the most suitable silvicultural prescription he can modify the prescription to accommodate other stand management concerns. The user must balance silvicultural and, for example, range management considerations to determine the best overall stand management strategy. Figure 10 schematically portrays the development of a silvicultural prescription.

In this guide we emphasize the establishment stage of a silvicultural prescription. If this stage is altered due to other stand management concerns there will be effects, ranging from minimal to drastic, on the establishment and growth of selected tree species and/or on future stand productivity.

We must emphasize that this guide is a first attempt. Silviculturists who apply the information in this guide must pass on their experiences so that future revisions will reflect their findings.

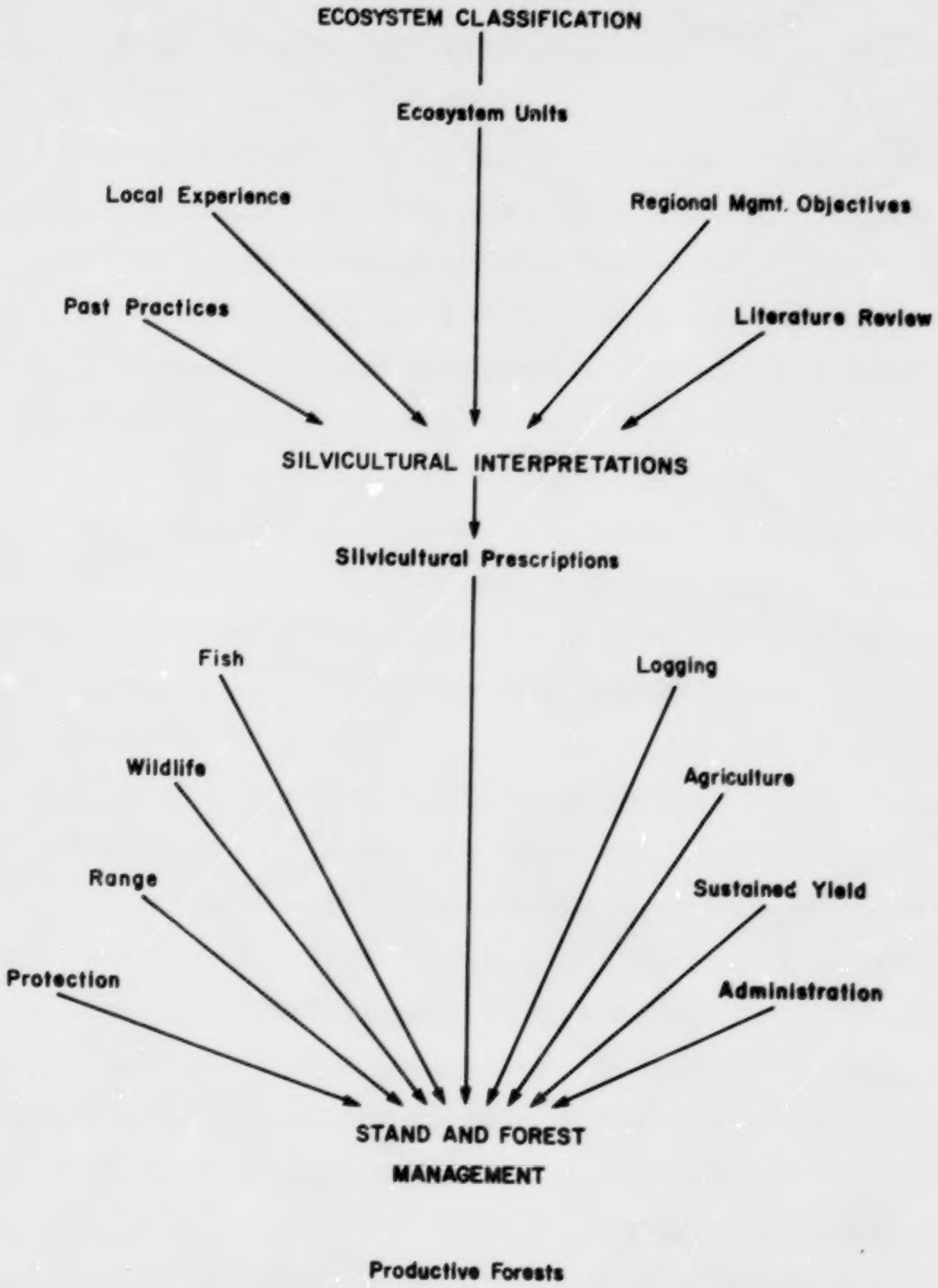

ECOSYSTEM CLASSIFICATION
Ecosystem Units
Local Experience
Regional Mgmt. Objectives
Past Practices
Literature Review
SILVICULTURAL INTERPRETATIONS
Silvicultural Prescriptions
Fish
Logging
Wildlife
Agriculture
Range
Sustained Yield
Protection
Administration
STAND AND FOREST
MANAGEMENT
Productive Forests

Figure 10. The relationship between classification, prescription and management.

9.2 Species Selection, Advanced Regeneration and Stock Type for Planting

9.2.1 Species selection

Guidelines for species selection are based on the silvics of the species in relation to the site factors found in each ecosystem association. The site factors considered important in species selection are: (1) ecological moisture and nutrient regimes, (2) humus form, (3) soil family particle size, (4) soil drainage, (5) effective rooting depth, and (6) competing vegetation. Other criteria, such as rotation length, that could affect species choice were not considered.

Species selection for certain ecosystem associations is easy. For example, lodgepole pine is the only suitable species for the Pine - moss ecosystem association (SBSel/03). Species selection on other ecosystems, such as the Mesic bunchberry - moss, five-leaved bramble subassociation (SBSel/01.2) where both lodgepole pine and spruce are acceptable, is more difficult, although less critical. Only long-term monitoring will determine the most suitable species or mixture of species for this subassociation.

9.2.2 Advanced regeneration (Smith and Craig 1968, 1970; Alexander 1974; Crossley 1976; Herring and Etheridge 1976; Gravelle 1977; Herring 1977, 1979; Klinka 1977; Johnstone 1978)

The decision to manage advanced regeneration should be made prior to logging. The decision will be based on the ecological suitability of the species to the site, as well as the quality and quantity of the advanced growth.

The majority of literature on the management of advanced regeneration in B.C. and elsewhere has dealt with the true fir species. The above papers are recommended supplementary reading. Advanced regeneration of interior spruce and true firs have similar silvical characteristics (Geisler et al. 1982). Therefore, the information provided on the true firs can also be applied to spruce. The major points of the above papers are:

a) Any form of logging is likely to destroy a substantial proportion of the advanced regeneration on a site, although total destruction is probably rare. Expect between one-half and two-thirds of the advanced regeneration existing in a stand to be destroyed during the logging operation.

b) Age and size of advanced regeneration are not directly related, making an accurate age prediction based on relative size impossible. Age alone can not be used as a predictor of growth performance or merchantable value.

c) The quality of advanced regeneration in relation to its potential for forming a second rotation crop is best described in terms of its vigour, susceptibility to defect and decay, and the growth form of its stem and crown. Advanced regeneration of subalpine fir has similar silvical characteristics to that of amabilis fir (Geisler et al. 1982). Consult an unpublished, undated Vancouver District Reforestation Report for a useful guide to acceptable quality of amabilis fir (and, by inference, subalpine fir) regeneration.

d) In most cases, advanced regeneration consists of shade tolerant species. Therefore, in the SBSd spruce is the dominant advanced regeneration whereas in the SBSel subalpine fir is the dominant advanced regeneration. However, due to edaphic or historical site factors spruce may be dominant in localized areas of the SBSel. These sites may be managed to preserve the advanced Sxw regeneration if it is a preferred or acceptable species.

9.2.3 Stock type for planting

If a species goes into check on a particular site after satisfactory planting, then there may be a problem in species selection, stock type selection, or stock handling. Correct species and stock type selection, followed by proper stock handling in transport and during planting, are crucial for successful establishment and subsequent growth of tree seedlings.

Preferable stock type for given site conditions will be discussed in general terms only in this guide. The preferred stock types are in many ways like politicians, one year they are in favour, the next year they are not. This is often due to variability in identical stock types among nurseries. Because of this we will discuss the physical characteristics a stock type should possess. Table 7 presents the most commonly used stock types[1] in the SBS with their optimum height and caliper characteristics. Seedlings with these characteristics will be considered of optimum size for the particular stock type. At present, obtaining stock of optimum size is an objective of the Prince Rupert Forest Region.

Where site conditions are favourable, the selection of stock type is very flexible. When site conditions are severe, such as on sites having brush competition (see Section 9.3), the selection of stock type is much less flexible. A tall, sturdy, well-balanced seedling, such as a transplant, is required to withstand the physical competition and stresses associated with severe brush site conditions.

Species choice for a site may have a bearing on stock type selection. Bare root stock of interior spruce, for example, has released poorly on interior sites in the Prince Rupert Forest Region. We recommend spruce plug or plug transplant stock on brush sites to overcome this delay. When using plug stock on soil types subject to frost heaving, the heaving can be eliminated to a large extent by setting the plug approximately 1 cm below the ground

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[1] For further information on stock types see the Silviculture Manual, Chapter 4, Appendix 4-4.

Table 7. Optimum size for stock commonly used in the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.

Stock Type	Height (cm)	Caliper (diamter of root collar) (mm)
PSB 211	12.0	2.0
PSB 313	14.0	2.5
PSB 415	16.0	3.0
BR 2 + 0	15.0	3.0
BR 1 1/2 + 1/2	15.0	3.5
BR 2 + 1	20.0	4.5
BR 2 + 2	25.0	5.5
PSB 211 + 1	15.0	3.0

surface and pressing a small amount of soil over the top (Walker et al. 1980). Bare root stock could also be used to reduce frost heaving.

Table 8 presents guidelines for stock type selection with comments on the important factors to consider in the selection.

9.3 Competing Vegetation

Brush[2] will invade and grow vigourously following logging on our productive forest sites. Brush species often take control of these sites

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[2] Brush here refers to all deciduous trees, shrubs and herbs that inhibit the successful establishment and growth of selected coniferous tree species.

Table 8. Guidelines for stock type selection in the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.

Soil particle size	. Moisture regime . Nutrient regime	Conditions influencing stock type choice	Examples of acceptable stock types
Coarse textured soils	. Submesic - mesic (rapidly - moderately well drained) and . Oligotrophic - mesotrophic (very poor - medium)	-competing vegetation not expected -frost heaving not expected -mostly lodgepole pine sites	PSB 211; BR 1 1/2 + 1/2, 2+0 Stock should have a high ratio of root mass to top growth
	. Mesic - hygric (moderately well - poorly drained) and . Mesotrophic - eutrophic (medium - very rich)	-competing vegetation expected on subhygric/permesotrophic and moister, richer sites -frost heaving not expected -both lodgepole pine and spruce sites	-Stock requires rapid initial height growth: PSB 211, 313, 415; plug + 1; BR 1 1/2 + 1/2, 2+1
Fine textured soils	. Submesic - mesic (rapidly - moderately well drained) and . Oligotrophic - mesotrophic (very poor - medium)	-competing vegetation not expected -potential frost heaving on silty soil types -possible compaction problems in cavity with dibble planted plugs -mostly lodgepole pine sites, some spruce	Plug + 1; BR 1 1/2 + 1/2, 2 + 0 Note: plug + 1 should be mattock- or shovel-planted
	. Mesic - hygric (moderately well - poorly drained) and . Mesotrophic - eutrophic (medium - very rich)	-competing vegetation a definite problem -frost heaving potential more severe here because of moister soils -plug root growth may be restricted in clayey soils -screefing may be required -mostly spruce and subalpine fir sites, some pine	-Stock requires rapid initial height growth. -Transplant stock; sturdy tree with good caliper: BR 2+1, 1 1/2 + 1/2, 2+2; plug+1;PSB313,415. Plugs mattock- or shovel-planted -bare root may be a better choice on silty, heavy soils

Table 9. Common trees, shrubs, and herbs that compete with young coniferous trees in the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.

Trees	
Alder	*Alnus* spp.
Black Cottonwood	*Populus balsamifera* ssp. *trichocarpa*
Trembling aspen	*Populus tremuloides*
Willow	*Salix* spp.
Shrubs	
Black twinberry, honeysuckle	*Lonicera involucrata*
Currants and gooseberries	*Ribes* spp.
Hardhack and birch-leaved spiraea	*Spiraea* spp.
Highbush-cranberry, squashberry	*Viburnum edule*
Prickly rose	*Rosa acicularis*
Raspberry	*Rubus idaeus*
Red-osier dogwood	*Cornus sericea*
Snowberry	*Symphoricarpos albus*
Thimbleberry	*Rubus parviflorus*
Herbs	
Cow-parsnip	*Heracleum sphondylium*
Fireweed	*Epilobium angustifolium*
Sod-forming grasses	

Table 10. Criteria for identification of sites subject to potential brush competition with coniferous trees in the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.

	Potential competition		
Criteria	Low	Moderate	High (to extreme)
Moisture regime	mesic	mesic - subhygric	subhygric - hygric
Nutrient regime	oligotrophic - mesotrophic	mesotrophic - permesotrophic	subeutrophic - eutrophic
Drainage	moderately well - well	well - imperfectly	imperfectly - poorly
Seepage	not present	may be periodically present	periodically to permanently present
Water table	not present within 100cm of ground surface	rarely present within 100 cm of ground surface	frequently present within 50 cm of ground surface
Meso slope position	variable	middle, lower, toe, (level)	lower, toe, level, depressional
Mottling or gleying in upper 50 cm	not present	may be present	frequently present
Ah horizon	not present	may be present	frequently present
Relative rate and dominant mode of decomposition in humus forms	slow, fungal (Mor)	moderate, fungal/ zoogenous	moderate to rapid, zoogenous (Moder)
Dominant understory[1] in forested ecosystems	moss and herbs, few shrubs	mostly herbs, moderate occurrence of shrubs	competitive shrubs and deciduous trees, as well as vigourous herbs.

[1] The quality and vigour of these species is directly related to crown closure, as well as moisture and nutrient regime.

if coniferous tree species are not rapidly established. Once brush species have become dominant, site reclamation for conifer establishment is neither easy nor cheap.

The purpose of this section is to help identify sites where brush competition poses a problem for successful establishment and growth of coniferous tree species. The brush species considered to pose the greatest problems are presented in Table 9. Certain criteria were commonly found in sites subject to brush competition. Table 10 lists the criteria that we consider significant. It should be stressed that all criteria may not apply to a given site. Rely on the majority of the criteria to indicate the level of potential competition.

Moist rich ecosystems, our best timber-producing sites, are localized and often not widespread in the SBS of the Prince Rupert Forest Region. They are usually found at the lower slope positions or near drainage channels. These moist rich ecosystems are not difficult to identify and should be scheduled for prompt reforestation. Table 11 summarizes these ecosystems. The majority of the forested ecosystems in the SBS are more or less mesic and, unless severely disturbed, are of little concern in terms of brush competition.

9.4 Site Preparation

Silvicultural site preparation is designed to improve conditions for the establishment and growth of selected tree species. This is generally accomplished by reducing competition; giving desirable species a "headstart"; enhancing the potential for natural regeneration;

improving planter access; or improving the soil moisture, nutrient or temperature regimes.

Low soil temperature is one of the most important limiting factors for tree growth in the SBS (McMinn, personal communication 1980). Site preparation treatments that increase temperatures by exposing mineral soil, without causing severe moisture deficits, should benefit early tree growth.

At present, site preparation in the SBS is commonly accomplished by using machinery or prescribed fire. Other methods of reducing competing vegetation include the use of herbicides, livestock, or domestic forages. Although not often thought of in this way, timber harvesting is another form of site preparation. The way a site is logged can have a dramatic effect upon further treatments required to establish tree seedlings.

9.4.1 Mechanical site preparation

In this guide we will discuss site conditions that determine the success or failure of mechanical site treatment. Site conditions include soil moisture, nutrient, and temperature regimes; soil aeration, texture, and structure; competing vegetation; slash; and topography.

Logging

The time of year a given site is logged in the SBS is generally dictated by a combination of access to the site and the seasonal wetness of the site. The choice of equipment generally depends on topography, timber size, and timber volume. The final choice of season and equipment type blends environmental and economic concerns.

Table 11. Summary of ecosystems with significant potential for brush competition with conifers in the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.

Subzone	Ecosystem association		Potential brush competition
SBSd (Spruce)	/01	Mesic rose - peavine - moss	low - moderate
	/08	Moist shrub - forb	moderate - high
	/09	Spruce - horsetail	high - moderate
	/10	Cottonwood bottomland	high
SBSel (Subalpine fir)	/01.2	Mesic bunchberry - moss, Five-leaved bramble sub association	low - moderate
	/06	Moist thimbleberry - forb	moderate - high
	/07	Oak fern	moderate
	/08	Devil's club	high
	/09	Horsetail flat	high - (extreme)

The silviculturist might choose equipment as follows:

a) If summer logging and natural regeneration are planned, the combination of a snipper-cat and line skidders is preferable to a feller-buncher/grapple-skidder combination due to the higher degree of site disturbance associated with the first method. With the increased disturbance of the snipper-cat treatment there may be no need for further mechanical site preparation to gain satisfactory regeneration. Further treatment would probably be required if the feller-buncher was used, and may represent an additional cost.

(b) In winter logging, choice of equipment is silviculturally less important. Winter logging may be the answer on sites where protection of the soil organic horizons is essential for maintenance of site productivity.

Post logging

There is a variety of site preparation equipment available to use following logging. This equipment falls into three broad types: (1) types such as chain drags and sharkfin drums that are dragged over a site; (2) types such as a brush-blade or straight-blade that scrape a site; (3) types such as the Bräcke, Leno, TTS disc trencher, or madge landbreaker that patch-scarify or incorporate mineral soil and organic matter.

Drag scarification equipment is normally used in the SBS to enhance natural regeneration or improve planter access on sites that are mesic or drier and mesotrophic or poorer. This equipment minimizes scraping or gouging of the soil. As a side effect drag scarification often mixes organic materials and mineral soil, which can benefit site productivity. Because competing vegetation is rarely a problem on mesic/mesotrophic and drier/poorer sites, there are few limitations on the use of drag scarification equipment on such sites. Drag scarification can be used as an alternative method to reduce fire hazard on sites where prescribed burning will significantly degrade productivity.

When deciding if scraping or patch-scarifying treatments pose a problem to the successful establishment and growth of tree seedlings, examine (1) depth, texture, and organic matter content of the upper mineral soil horizons; (2) humus form; (3) presence of root-restricting layers; and (4) potential for competing vegetation. In general:

a) The nutrient availability on sites having deep, loamy textured mineral horizons with surface soils rich in organic matter is rarely adversely affected by mechanical treatments. However, exposing mineral soil on these sites may greatly increase the brush competition.

b) On sites where soil nutrients are concentrated in the soil organic horizons, and on sites with deep, coarse textured soils, large scale removal of the organic horizons is detrimental to site productivity. Patch-scarifiers, however, should cause little harm to such sites.

c) On soils with finer than loamy textures or soils with structureless compact layers at shallow depths, planting must take place on the mounds rather than in the depressions or gouges produced when equipment is used that scrapes or patch-scarifies the site. The ability of coniferous tree seedlings to become established and grow well is impaired on structureless fine textured soils (Smith and Wass 1979; McMinn, personal communication 1980; Walker and Johnson 1980).

d) Competing vegetation will be a problem on moist rich sites. In order to be successful, mechanical eradication of existing brush must remove most of the soil organic horizons and expose mineral soil. This provides ideal conditions for the re-invasion of competing vegetation that will probably require future treatment. The benefits of mechanical treatment for controlling brush must also be weighed against the possible reductions in site productivity such a drastic treatment may incur.

The use of patch-scarifying equipment to create mounds on which to establish trees may solve many problems. Tree growth has been shown to be superior on mounds compared to the scalped sites and the untreated sites in sub-boreal spruce areas of the Prince George Forest Region (McMinn 1979). Trees established on mounds are also thought be be in a better competitive position than those established on the flat or in depressions.

9.4.2 Prescribed fire

As a site preparation method in the SBS, prescribed fire is presently used to improve planter access, control stocking and species, temporarily reduce competing vegetation, and control disease. The effects of prescribed fire on a site will depend on the intensity and duration of the fire. The impact of the fire will also depend on the type of mineral soil, type and thickness of the soil organic horizons, topography, climate, plant and animal communities present, and type and amount of logging residue.

In this section we cover the uses of prescribed fire for stocking control and reduction of competing vegetation.

Stocking control

In most sub-boreal ecosystems, prescribed fire facilitates planting and provides a successional environment suitable for the establishment and growth of seral species. For example, on the mesic and poorer ecosystems where lodgepole pine is the preferred species, a relatively light surface fire can be used to establish pine at the expense of advanced regeneration of spruce and subalpine fir. In this case, the fire must be of such an intensity that no more than the litter (L) layer is burned, if site productivity is to be maintained (see Section 9.4.3).

Burning on mesic/mesotrophic or slightly more productive ecosystems may or may not be desirable to the silviculturist, depending upon the tree species selected. Following burning, succession on such sites is pushed back. This favours the growth of light-demanding or pioneer species. Spruce, a species that prefers partial shading (or a cool, moist surface) for optimum establishment but full sunlight for subsequent growth (Day 1964), will not be favoured by burning on mesic/mesotrophic or slightly better sites. If burning is necessary on such ecosystems then lodgepole pine may be a better choice. Burning should present no problems for the establishment of spruce in moist rich ecosystems.

Control of competing vegetation (Dobbs 1972; Alexander 1974; McMinn 1974; Dyck 1976; Cleary et al. 1978)

To set back competing vegetation significantly a fire must prevent resprouting; this means the fire must be intense enough to remove the majority of the soil organic horizons, and should be applied when the undesirable plants have low energy reserves in their roots (i.e., late spring-early summer). Fire should be used for brush control only where site productivity will not be adversely affected by major removal of the organic horizons.

As the intensity of burn required increases, the risks involved also increase. Intense burns should only be used on cut-blocks that are suitable for a safe hot burn. Such treatments will probably require pre-logging identification of sites where fire will be used to control competing vegetation. Only then can cut-blocks be designed to carry an intense burn safely. Post-planting cultivation or herbicide treatments may still be required to slow the brush invasion of the site.

9.4.3 Maintenance of site productivity (Feller 1972; Harris and Farr 1974; Martin 1976; Harvey et al. 1976, 1979a, 1979b; Davis et al. 1979; McMinn 1979; Macadam 1981)

The following discussion deals primarily with the effects of prescribed fire on site productivity. However, analogies can be drawn with the effects of mechanical site preparation.

There is little doubt that soil organic horizons and organically enriched mineral horizons are at the heart of forest productivity.

Accumulation, decomposition, and mineralization of organic matter are vital to site maintenance, and are, therefore, vital silvicultural concerns.

At present, opinions vary as to the optimum amount and kinds of organic matter needed to maintain or improve site productivity after timber is harvested. However, some points are clear:

1. On dry poor ecosystems:
    a) The available supply of soil nutrients is concentrated in the soil organic horizons, and available moisture is enhanced and protected by the organic horizons.
    b) Destruction of the soil organic horizons will have an adverse effect on the conservation and availability of nutrients and moisture through nitrogen volatilization, accelerated leaching, and hydrophobicity. The sterilizing effect of hot fires will also deplete the soil microbiota (fungi, algae, bacteria, soil animals, etc.). This can lead to long-term detrimental effects on soil productivity.
    c) The blackening of the soil surface and removal of shading vegetation and slash by fire results in higher daytime temperatures at the soil surface. This can aggravate moisture stress, particularly on dry south facing slopes.
    d) Destruction of the soil organic horizons accelerates soil erosion on steep slopes.
    e) Retention of decaying wood and other organic materials has benefits equivalent to long term fertilization and moisture

conservation, and provides habitat for the microbiotic community.

2. On moist rich ecosystems:
   a) Removal of the soil organic horizons is not expected to affect adversely the conservation and availability of nutrients and moisture due to the rapid rate of biomass production and decay in these ecosystems.
   b) Removal of the soil organic horizons tends to increase springtime soil temperatures in the rooting zone, generally benefiting productivity.
   c) Erosion may be accelerated on floodplains and steep slopes following removal of soil organic horizons.

We have emphasized maintenance of site productivity in the foregoing discussion of mechanical site preparation and prescribed fire. On dry sites this usually means maintenance of the soil organic horizons. We believe this is the prudent approach until further information is available on the role of soil organic horizons in the maintenance and improvement of site productivity.

If site productivity has been reduced by removal of the soil organic horizons, consideration must be given to management practices that will reestablish or improve the productivity of the disturbed site. Examples of such practices would be the application of fertilizers or sowing of nitrogen-fixing plants.

9.4.4 Herbicides (National Research Council of Canada 1978; Stewart 1978; Warnock and Lewis 1978; Daniel et al. 1979; Newton, M. and F.B. Knight 1981; Newton, M. and F.N. Dost 1981, in press)

Herbicides used alone or in conjunction with other site preparation treatments are an effective means of reducing brush competition. The topic of herbicide use in silviculture is much too broad to explore in this guide. However, a few comments are in order here:

a) Herbicides could be used to control vegetation on any of the SBS ecosystem associations that are considered to have potential for brush competition. See section on competing vegetation (9.3).

b) Herbicides are the least (apparently) expensive of presently used methods to control competing vegetation.

c) Herbicide use has in cases proven to be detrimental or in conflict with other natural resources and human health, and is therefore controversial for reasons outside the realm of silviculture.

9.4.5 Livestock and domestic forages (Clark 1975; Clark and McLean 1975, 1978)

Information on the use of livestock and/or domestic forages for site preparation is rather limited. Because of widespread grazing in the spruce subzone, livestock could possibly be used to help control brush on forested sites. Sowing of domestic forages has potential in both subzones to control brush and improve site productivity. On many of the poorer ecosystem associations especially, sowing of domestic forages may be a way of improving site productivity, for both trees and livestock, but sod-forming species especially will increase the competition for water.

The use of grazing livestock and/or the sowing of domestic forages as site preparation techniques have been studied in the Kamloops Forest Region, but further examination is required in the SBS.

9.5 Insects and Disease

Insect and disease problems occur in all ecosystems of the SBS. Pathological problems must be recognized and taken into account in all silvicultural prescriptions. The identification and treatment of the various forest insects and diseases are thoroughly covered elsewhere and will not be dealt with in detail here. Table 12 presents a summary of the major insects and diseases of commercial tree species in the SBS with comments on when they are a problem and where further information can be found.

9.6 Regeneration Systems (Troup 1928; Smith 1962; USDA Forest Service 1973; Alexander and Edminster 1977; Frank and Blum 1978)

At present, clearcutting is the most common logging method in the SBS. There are, however, many other systems that could be used, including selection, shelterwood, seedtree, and strip systems. Except for a modified form of the strip system, these other systems have not been used to any extent.

Table 12. Major insects and diseases of commercial tree species of the Sub-Boreal Spruce Zone, Prince Rupert Forest Region.[1]

Host Species	Insect/Disease	Problem Stage	References
Pine	mountain pine beetle	older stands	pest leaflets[2]
	dwarf mistletoe	stand tending; regeneration	pest leaflets; PSW31 USDA[3]
	western gall rust	stand tending	pest leaflets
	stalactiform blister rust	stand tending	pest leaflets
	atropellis canker	stand tending	pest leaflets
	heart rots/root rots	stand tending	pest leaflets
Spruce	spruce bark beetle	older stands	pest leaflets
	Cooley spruce gall aphid	regeneration	pest leaflets
	pineus aphid	regeneration	pest leaflets
	dieback disease	plantations	
	snow blight disease	plantations	
Subalpine fir	heart rots	management of advanced regeneration; stand tending	pest leaflets
	balsam bark beetle	older stands	pest leaflets
Above spp.	black army cutworm	plantations after fire	pest leaflets

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[1] Other insects and diseases are present but do not in general pose a hazard to forest management at the present time.

[2] Pest leaflets can be obtained from the Pacific Forest Research Centre, Environment Canada, Victoria.

[3] Scharpf and Parmeter (1978).

The selection regeneration system, or uneven-age silviculture, is the periodic marking and harvesting of single trees or small groups of trees by diameter groups. The system requires the periodic removal of defective, slow-growing, or otherwise unwanted trees as part of the logging operation, and creates and maintains an uneven-aged stand of trees with specific diameter distribution. The goals of the selection system are improvement of species composition, stand density, and stand quality while maintaining forest cover. The system encourages the continuous establishment of natural reproduction and is particularly suitable for shade-tolerant species such as spruce and subalpine fir. We believe the selection system would work well in the moister richer ecosystems of the SBS where the objective is to regenerate spruce naturally or artificially.

In the shelterwood and seedtree systems the new crop is established under the cover of the old crop. Either natural or artificial regeneration can be used with the shelterwood system. The shelterwood system could be used to regenerate lodgepole pine although it could not be used in mistletoe-infested areas. Either system could be used to regenerate spruce or subalpine fir in the SBS.

In the spruce subzone the selection and shelterwood systems would be ideal for sites being managed for both cattle and timber production.

9.7 Growth Class, Basal Area, and Volume by Ecosystem Association

Basal area, volume, and site index were calculated for each forested ecosystem association. Site indices were determined using equations from

Table 13. Some mensurational statistics[a] for the Sub-Boreal Spruce Zone, spruce subzone (SBSd) of the Prince Rupert Forest Region.

Ecosystem Association	No. of Stems/ha	Basal Area (m^2/ha)	Volume (m^3/ha)	Growth Class (at 60 years)[b]			Growth Class (at 100 years)[b]		
				Pine	Spruce	Aspen	Pine	Spruce	Aspen
SBSd/03	2610	53	-	4[c]	-	-	5[c]	-	-
SBSd/06	490	60	-	-	-	-	-	-	-
SBSd/07	1370 ± 690	51 ± 9	-	3-7	2-4	-	5-9	5-7	-
SBSd/01	1870 ± 540	60 ± 8	240	5-6	3-4	3[c]	6-7	6-7	5[c]
SBSd/08	850 ± 180	53 ± 12	330 ± 30	6-8	4-6	4[c]	7-10	8-10	6[c]
SBSd/09	1070 ± 990	81 ± 33	-	-	2-6	-	-	5-10	-
SBSd/10	960	67	160	-	7[c]	-	-	10[c]	-

[a] Confidence limits are set at 95%. Values are recorded when n _ 3; confidence limits are recorded when n _ 5.

[b] Ranges of growth classes are shown in Table 15.

[c] Based on 3-4 samples.

Table 14. Some mensurational statistics[a] for the Sub-Boreal Spruce Zone, subalpine fir subzone western variant (SBSel) of the Prince Rupert Forest Region.

Ecosystem Association	No. of Stems/ha	Basal Area (m^2/ha)	Volume (m^3/ha)	Growth Class (at 60 years)[b]			Growth Class (at 100 years)[b]		
				Pine	Spruce	Subalpine Fir	Pine	Spruce	Subalpine Fir
SBSel/02	1030	32	-	3[c]	-	-	5[c]	-	-
SBSel/03	1010 ± 970	41 ± 35	-	1-5	-	-	2-6	-	-
SBSel/04	1840 ± 670	55 ± 9	400 ± 160	3-5	2[c]	1[c]	5-7	6[c]	4[c]
SBSel/01.1(a)	2060 ± 770	61 ± 7)	430 ± 210	4-5	2-4	2-3	5-7	5-8	4-6
SBSel/01.1(b)	2520 ± 780	79 ± 12)		4-6	1-4	2-3	6-7	4-7	3-7
SBSel/01.2(a)	1500 ± 470	60 ± 9)	410 ± 220	4-6	3-5	2-3	5-8	6-8	4-6
SBSel/01.2(b)	1800 ± 760	70 ± 15)		4-7	2-4	1-4	5-9	4-8	5-[illegible]
SBSel/05[d]	2140 ± 1430	57 ± 36	360	4[c]	1[c]	-	6[c]	3[c]	-
SBSel/06	900 ± 240	62 ± 14	410	6-8	3-5	-	8-10	7-9	-
SBSel/07	980 ± 220	72 ± 10	-	6-8	3-5	2-3	7-10	6-9	5-7
SBSel/08	960 ± 640	59 ± 12	630	-	4-6	3-4	-	7-10	6-8
SBSel/09	1490 ± 1270	67 ± 17	690	6[c]	4-6	2[c]	8[c]	7-10	6[c]

[a] Confidence limits are set at 95%. Values are recorded when n _ 3; Confidence limits are recorded when n _ 5.

[b] Ranges of growth classes are shown in Table 15.

[c] Based on 3-4 samples.

[d] Data for black spruce (Picea mariana) are included with the other spruce species.

Hegyi et al. (1979). Due to the sampling methods and, in many instances, the small sample size, site indices are expressed as growth classes rather than as absolute figures. All values are arithmetic means calculated from data collected by the B.C. Ministry of Forests Research Section, Smithers.

Tables 13 and 14 present average stems per hectare, basal area, volume, and growth class for ecosystem associations of the spruce and subalpine fir subzones respectively. Use these data only to indicate relative differences between ecosystem associations at maturity and not as an indication of the ecosystem's potential productivity (cf. Eis et al. 1982). When examining the growth class figures the following cautions should be kept in mind:

a) The growth class of a species for a plot is often based on one or two trees only and figures may be based on as few as three plots.

b) Growth classes are based on the trees in the main canopy. That is, if 90% of the spruce on a dry site are 5 m tall (suppressed/intermediate) and two or three trees are 20 m tall (dominant/codominant) then the growth class is based on the 20 m tall trees. All of the lodgepole pine on this site may be 20 m tall so the growth class for spruce and lodgepole pine would be the same.

c) Growth classes are determined from site indices (see Table 15) which are based on one equation for each species. However, growth patterns for one species will differ between ecosystem associations.

d) Subalpine fir is often suppressed at early ages and later released so the total age of the tree is often much greater than the growing age.

Table 15. Height ranges of growth classes corresponding to mensurational data (Tables 13 and 14).

Growth Class	Height Range (m)
1	12.1 - 14.0
2	14.1 - 16.0
3	16.1 - 18.0
4	18.1 - 20.0
5	20.1 - 22.0
6	22.1 - 24.0
7	24.1 - 26.0
8	26.1 - 28.0
9	28.1 - 30.0
10	30.1 +

e) Sampling has been concentrated in mature stands. These stands all vary in species composition, density, and age. All three factors influence stand growth and productivity a great deal. This leads to difficulties in attempting to demonstrate differences in productivity among ecosystem associations.

9.8 Silvicultural Prescriptions

In the preceding sections we have discussed the major silvicultural topics that must be considered in the formulation of a silvicultural prescription for an ecosystem association. In sections 9.8.1 and 9.8.2 we present silvicultural prescriptions for each forested ecosystem association of the spruce and subalpine fir subzones, respectively. These prescriptions should serve as guides to aid in the selection of appropriate silvicultural treatments on an ecosystem basis. The ability to identify the ecosystem associations is a prerequisite for use of the prescriptions. The silvicultural prescriptions for the spruce and subalpine fir subzones are summarized in Tables 16 and 17, respectively.

The silvicultural prescriptions have been laid out in a manner that provides the user with an increasing level of detail as follows:

a) PRESCRIPTION - provides an overview of silvicultural management options on the ecosystem.

b) CAUTIONS - provides further information and qualifications on the PRESCRIPTION.

c) COMMENTS - elaborates further on the PRESCRIPTION AND CAUTIONS.

d) At this point if the user still does not understand the PRESCRIPTION he can consult the introductory section (Section 9.1) for more clarification.

The terms used under ACTIVITY in the silvicultural prescriptions are all self-explanatory except possibly Stand Tending. Stand Tending for the purposes of this guide refers to all silvicultural treatments that take place following natural and/or artificial regeneration. The abbreviation MSP is used to indicate mechanical site preparation.

9.8.1 Silvicultural Prescriptions - SBSd

Table 16. Summary of silvicultural prescriptions for the Sub-Boreal Spruce Zone, spruce subzone (SBSd) of the Prince Rupert Forest Region.[1]

Ecosystem Association	Logging	Species Choice [2]	Competing Vegetation	Mechanical Site Preparation	Prescribed Fire	Reforestation	Stand Tending
SBSd/01(a) Coarse textured phase	winter summer	P: Pl A: Sxw	low unless disturbance is excessive	OK	establish Pl: OK; establish Sxw: not recommended; avoid if adv. regen. acceptable	plant if req'd.	
SBSd/01(b) Fine textured phase	winter; dry periods in summer OK	P: Sxw, Pl	moderate	OK	establish Pl: OK; establish Sxw: not recommended; avoid if adv. regen. acceptable	plant if req'd.	
SBSd/02 SBSd/03	summer (winter)	P: Pl U: Sxw	not expected	OK	do not burn	natural regen. Pl	
SBSd/06	summer winter	P: Fd, Pl U: Sxw	not expected grasses could cause problems	OK	do not burn	plant if req'd.	
SBSd/07	summer (winter)	P: Pl A: Sxw	no problems unless disturbance is excessive; possible grass competition	OK	not recommended	plant Pl if required	
SBSd/08	winter (summer)	P: Pl, Sxw	moderate - high	OK	OK; avoid if adv. regen. acceptable	plant Pl, Sxw	plan to control brush following planting
SBSd/09(a) Fluvial phase	winter summer	P: Sxw A: Pl	moderate - high	OK	not recommended; avoid if adv. regen. acceptable	plant Sxw immediately	plan to control brush following planting
SBSd/09(b) Lacustrine phase	winter	P: Sxw	high - (extreme)	probably beneficial but usually not feasible	beneficial but difficult; avoid if adv. regen. acceptable	plant Sxw immediately	control brush following planting
SBSd/10	summer winter	P: Sxw	high - (extreme)	OK	not recommended	plant Sxw immediately	control brush following planting

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[1] This summary is presented as a review of ecosystem association prescriptions. However, it is not intended to be used as a shortcut for making ecosystem specific prescriptions.

[2] P = preferred; A = acceptable; U = unacceptable; Species abbreviations as in Appendix 2.

Table 17. Summary of silvicultural prescriptions for the Sub-Boreal Spruce Zone, subalpine fir subzone, western variant (SBSe1) of the Prince Rupert Forest Region.[1]

Ecosystem Association	Logging	Species Choice [2]	Competing Vegetation	Mechanical Site Preparation	Prescribed Fire	Reforestation	Stand Tending
SBSe1/01.1(a) Coarse textured phase	summer (winter)	P: Pl A: Sxw U: Bl	not expected unless disturbance is excessive	OK	avoid	plant Pl if required	
SBSe1/01.1(b) Fine textured phase	winter summer	P: Pl A: Sxw U: Bl	not expected unless disturbance is excessive	OK	use with care	plant if required	
SBSe1/01.2(a) Coarse textured phase	summer winter	P: Pl, Sxw U: Bl	not expected unless disturbance is excessive	OK	OK (use with care)	plant if required	
SBSe1/01.2(b) Fine textured phase	winter; dry periods summer OK	P: Sxw, Pl A: Bl	low - moderate	OK	establish Pl: OK establish Sxw: not recommended	plant if required	
SBSe1/02 SBSe1/03 SBSe1/04	summer (winter)	P: Pl U: Sxw, Bl	not expected	OK	do not burn	natural regen. Pl plant Pl if req'd.	
SBSe1/05	winter; dry periods summer OK	P: Pl A: Sxw, Sb U: Bl	not expected	OK	OK	plant Pl if req'd.	
SBSe1/06	winter; dry periods summer OK	P: Sxw, Pl A: Bl	moderate - high	OK	OK	plant Sxw, Pl	plan to control brush following planting
SBSe1/07	winter; dry periods summer OK	P: Sxw, Pl A: Bl	moderate unless disturbance is excessive	OK	OK	plant Sxw, Pl	plan to control brush following planting
SBSe1/08(a) Coarse textured phase	winter; dry periods summer OK	P: Sxw, Pl	high	to create mounds	OK	plant Sxw (Pl)	control brush following planting
SBSe1/08(b) Fine textured phase	winter	P: Sxw A: Bl, (Pl)	high	to create mounds	OK	plant Sxw	control brush following planting
SBSe1/09(a) Coarse textured phase	summer winter	P: Sxw A: Pl, (Bl)	high (extreme)	OK	not recommended	plant Sxw immediately	control brush following planting
SBSe1/09(b) Fine textured phase	winter	P: Sxw A: Bl, (Pl)	high (extreme)	probably beneficial but usually not feasible	beneficial but difficult	plant Sxw immediately	control brush following planting

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[1] This summary is presented as a review of ecosystem association prescriptions. However, it is not intended to be used as a shortcut for making ecosystem specific prescriptions.

[2] P = preferred; A = acceptable; U = unacceptable; Species abbreviations as in Appendix 2.

SBSd/01(a): MESIC ROSE - PEAVINE - MOSS: COARSE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL PREFERRED	
Logging	WINTER SUMMER	
Site Prep.		
MSP	OK	
Prescribed Fire	ESTABLISH PL: OK ESTABLISH SXW: NOT RECOMMENDED AVOID IF ADV. REGEN. ACCEPTABLE	-preferable to preserve shading vegetation
Reforestation	PLANT IF REQUIRED	-competing vegetation -for natural Pl (Sxw) have 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Pl Acceptable: Sxw
Logging	-natural regeneration: summer log with snipper cat and line skidders for optimum site disturbance
Site Prep.	
MSP	-drag equipment adequate for providing planter access or exposed mineral soil for natural regeneration
Prescribed Fire	-management of soil organic horizons is important if planning to establish Sxw rather than Pl. Sxw growth may be restricted initially by reduction in the soil organic horizons -burning should remove no more than the litter (L) layer
Reforestation	-natural regeneration of Pl is a good option -if brush competition expected do not rely on natural regeneration; plant
Competing Vegetation	-minor brush competition -if site disturbance is excessive expect increased brush competition -expect grass competition

SBSd/01(a) cont'd...

Other Options	-possible frost heaving on noninsulated silty textured soils -Selection, Shelterwood, or Seedtree regeneration systems if going for natural spruce regeneration -excellent potential for native range or tame pasture

SBSd/01(b): MESIC ROSE - PEAVINE - MOSS: FINE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW or PL PREFERRED	
Logging	WINTER; SUMMER DURING DRY PERIODS OK	-possible soil compaction on fine textured soils
Site Prep.		
MSP	OK	-exposure of frequently occurring fine textured soil horizons on fine loamy and fine clayey phases
Prescribed Fire	ESTABLISH PL: OK ESTABLISH SXW: NOT RECOMMENDED AVOID IF ADV. REGEN. ACCEPTABLE	-preferable to preserve some shading vegetation
Reforestation	PLANT IF REQUIRED	-competing vegetation -for natural Pl (Sxw) have 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Sxw or Pl
Logging	-windfall potential for both Pl and Sxw when root-restricting, structureless, fine textured or compact soils are near soil surface; adjust block layout
Site Prep.	
MSP	-drag equipment adequate for providing planter access or exposed mineral soil for natural regeneration -if scraping or scalping sites with fine textured soil horizons, plant on the mounds rather than in the depressions or gouges
Prescribed Fire	-management of soil organic horizons is important if planning to establish Sxw rather than Pl. Sxw growth may be restricted initially by reduction in the soil organic horizons -burning should remove no more than the litter (L) layer
Reforestation	-if brush competition expected do not rely on natural regeneration; plant

SBSd/01(b) cont'd...

Competing Vegetation	-moderate brush competition -if site disturbance is excessive expect increase brush competition -expect grass competition
Other Options	-possible frost heaving on noninsulated silty textured soils -Selection, Shelterwood, or Seedtree regeneration systems if going for natural spruce regeneration -excellent potential for native range or tame pasture

SBSd/02: PINE - LICHEN
SBSd/03: PINE - LICHEN - MOSS

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL PREFERRED	
Logging	SUMMER IF AIMING FOR NATURAL REGEN.	-slope -frequent thin soils over bedrock; severe disturbance results in site degradation
	WINTER	
Site Prep.		
MSP	OK	
Prescribed Fire	DO NOT BURN	-nutrients and moisture concentrated in the soil organic horizons
Reforestation	NATURAL REGEN. PL PLANT PL IF REQUIRED	-for natural Pl have: 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Pl Unacceptable: Sxw
Logging	-summer log when possible to provide disturbance for natural regeneration
Site Prep.	
MSP	-may be required
Prescribed Fire	-do not burn; loss of organic matter on these sites will result in loss of site productivity
Reforestation	-these ecosystems are marginal for timber production -site should be naturally regenerated if possible -if planting, plugs may be necessary due to rocky soils
Competing Vegetation	-not expected
Other Options	-defer from logging
Comments	-these ecosystem associations are better suited for purposes other than timber production

SBSd/06: DOUGLAS-FIR - SOOPOLALLIE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	FD OR PL PREFERRED	
Logging	SUMMER	-slope -thin soils over bedrock -severe disturbance results in site degradation
	WINTER	
Site Prep.		
MSP	OK	-slope
Prescribed Fire	DO NOT BURN	-nutrients and moisture are concentrated in the soil organic horizons -frequent coarse textured soils -colluvial landforms
Reforestation	PLANT IF REQUIRED	-rocky soils -grass competition

	COMMENTS
Species Choice	Preferred: Fd, Pl Unacceptable: Sxw
Logging	-Shelterwood or Seedtree systems recommended to regenerate Fd
Site Prep.	
MSP	-slopes will often be too steep for mechanical treatments -drag equipment adequate for providing planter access or exposed mineral soil for natural regeneration
Prescribed Fire	-will result in site degradation on shallow soils
Reforestation	-if planting, plug stock will be necessary on the rocky soil types
Competing Vegetation	-generally should be no problem; possible problem with grasses
Other Options	-defer from logging -good potential for native range or tame pasture

SBSd/06 cont'd...

Comments	-this ecosystem is rare in the study area; conservation of this ecosystem must be a priority; selective logging of Sxw and Bl may be required to prevent takeover of some (moister) sites by the more shade tolerant conifers and thus to maintain dominance by Fd (J. van Barneveld personal communication).

SBSd/07: SUBMESIC BUNCHBERRY - MOSS

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL PREFERRED	
Logging	SUMMER IF AIMING FOR NATURAL REGEN.	-possible soil compaction on fine textured soils
Site Prep.		
MSP	OK	-exposure of frequently occurring fine textured soil horizons -occasional steep slopes
Prescribed Fire	NOT RECOMMENDED	-nutrients and moisture concentrated in the soil organic horizons
Reforestation	PLANT PL IF REQUIRED	-for natural Pl have: 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Pl Acceptable: Sxw as a minor component
Logging	-for natural regeneration: summer log with snipper cat and line skidders for optimum site disturbance
Site Prep.	
MSP	-can be used to reduce fire hazard instead of prescribed burning -if scraping or scalping sites with fine textured soil horizons, plant on the mounds rather than in the depressions or gouges
Prescribed Fire	-can be detrimental to this ecosystem unit; can reduce soil productivity -if required, the burn should remove only the litter (L) layer
Reforestation	-moisture may be a limiting factor on drier sites; if planting, use stock with a well developed root system

SBSd/07 cont'd...

Competing Vegetation	-not expected, unless disturbance is excessive -grass competition may cause problems, although probably not on coarser, more acidic soils.
Other Options	-if grass competition is expected it may be useful to try a scalping machine (only on loamy and coarser soils) to reduce competition for moisture for the planted trees. On sites with finer than loamy soils try planting on mounds -high potential for native range or tame pasture

SBSd/08: MOIST SHRUB - FORB

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW AND PL PREFERRED	
Logging	WINTER; DURING DRY PERIODS SUMMER OK	-possible soil compaction on fine textured soils
Site Prep.		
MSP	OK	-may increase brush competition -exposure of occasionally occurring fine textured soil horizons -slope -slash
Prescribed Fire	OK (AVOID IF ADV. REGEN. ACCEPTABLE)	
Reforestation	PLANT SXW, PL	-competing vegetation; plant during first spring following last treatment

	COMMENTS
Species Choice	Preferred: Sxw, Pl; Pl favoured on well-drained sites -Sxw shows its best growth on the Nechako Plateau in this ecosystem unit
Logging	-logging method will depend on slope and timber size
Site Prep.	
MSP	-good alternative for providing planter access on sites where burning is undesirable -if scraping or scalping sites with fine textured soil horizons, plant on the mounds rather than in the depressions or gouges
Prescribed Fire	-burning should not significantly reduce the soil organic horizons
Reforestation	-plant sturdy vigourous stock
Competing Vegetation	-moderate to high potential for brush competition -deciduous trees often present; try to minimize sprouting and suckering

SBSd/08 cont'd...

Stand Tending	-plan to reduce brush competition to maintain the plantation
Other Options	-Selection or Shelterwood regeneration systems for Sxw regeneration -aspen would become an acceptable species in this ecosystem if and when it becomes a commercial species -high potential for native range or tame pasture

SBSd/09(a): SPRUCE - HORSETAIL: FLUVIAL PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW PREFERRED	
Logging	WINTER	
	SUMMER	-disturbance of soil organic horizons may accelerate soil erosion if floodplain is active
Site Prep.		
MSP	OK	-slash -could accelerate soil erosion on active floodplains -may increase brush competition
Prescribed Fire	NOT RECOMMENDED AVOID IF ADV. REGEN. ACCEPTABLE	-available moisture and nutrients are concentrated in the upper soil horizons
Reforestation	PLANT SXW IMMEDIATELY	-high brush potential -occasional thick soil organic horizons -may be occasional flooding

	COMMENTS
Species Choice	Preferred: Sxw Acceptable: Pl
Logging	-summer logging; excessive soil disturbance will result in increased brush competition and possible soil erosion
Site Prep.	
MSP	-on well-drained sites planting in scalped areas or depressions OK
Prescribed Fire	-soils are generally coarse textured and well-drained; soil organic horizons are generally thin; organic horizons should be maintained to protect the sites from erosion damage

SBSd/09(a) cont'd...

Reforestation	-plant tall large-caliper stock -occasional thick soil organic horizons could pose problems without site preparation -if summer logged, plant that fall or next spring -if winter logged, plant first spring or fall following last treatment
Competing Vegetation	-expect moderate to high brush competition; mainly shrubs and deciduous trees
Stand Tending	-plan to reduce brush competition to maintain the plantation
Other Options	-Selection regeneration systems -horse logging -cottonwood would become an acceptable species on well-drained sites if and when it becomes a commercial species -high potential for native range or tame pasture

SBSd/09(b): SPRUCE - HORSETAIL: LACUSTRINE PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW PREFERRED	-sites usually too wet for Pl establishment
Logging	WINTER	
Site Prep.		
MSP	PROBABLY BENEFICIAL BUT USUALLY NOT FEASIBLE	-high water table -slash
Prescribed Fire	BENEFICIAL BUT DIFFICULT AVOID IF ADV. REGEN. ACCEPTABLE	-wet conditions make burning difficult
Reforestation	PLANT SXW IMMEDIATELY	-competing vegetation -occasional thick soil organic horizons -high water table

	COMMENTS
Species Choice	Preferred: Sxw
Logging	-methods depend on site and timber conditions
Site Prep.	
MSP	-has potential; MSP must produce raised areas for planting; seedlings established on mounds should have a competitive advantage -sites will often be too wet for equipment use
Prescribed Fire	-burning no problem in terms of maintaining site productivity -should improve site plantability; may reduce brush competition for a year, but may increase brush competition later
Reforestation	-plant tall large-caliper stock -thick organic layers could pose problems without site preparation
Competing Vegetation	-expect high to extreme brush competition; mainly shrubs and deciduous trees
Stand Tending	-plan to reduce brush competition to maintain the plantation
Other Options	-Selection regeneration system -horse logging -high potential for native range or tame pasture

SBSd/10: COTTONWOOD BOTTOMLAND

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW PREFERRED	
Logging	SUMMER	-disturbance of soil organic horizons may accelerate soil erosion on active floodplains
	WINTER	
Site Prep.		
MSP	OK	-slash
Prescribed Fire	NOT RECOMMENDED	-could accelerate soil erosion on active floodplains -could increase sprouting and suckering of deciduous trees
Reforestation	PLANT SXW IMMEDIATELY	-competing vegetation -flooding

	COMMENTS
Species Choice	Preferred: Sxw - spruce shows excellent growth on these sites
Logging	-summer logging: -avoid skidders to reduce excessive soil disturbance -cat yarding good for knocking down brush and minimizing excessive soil disturbance -MSP should not be required -winter logging: -MSP probably required to facilitate planting
Site Prep.	
MSP	-to produce plantable spots; method depends on amount of slash
Prescribed Fire	-soils are generally coarse textured; soil organic horizons are generally thin (1-8 cm); organic horizons should be maintained to protect the sites from erosion damage during flooding

SBSd/10 cont'd...

Reforestation	-plant tall large-caliper stock -if summer logged, plant that fall or next spring -if winter logged, plant first spring or fall following last treatment
Competing Vegetation	-expect high to extreme brush competition; mainly shrubs and deciduous trees
Stand Tending	-plan to reduce brush competition to maintain the plantation
Other Options	-Selection regeneration systems -horse logging -cottonwood would become an acceptable species if and when it becomes a commercial species
Comments:	-at present, many of these sites do not support commercial stands of timber, and these sites will not return to commercial species without a concentrated rehabilitation program.

SBSe1/01.1(a): MESIC BUNCHBERRY - MOSS, BLACK HUCKLEBERRY SUBASSOCIATION: COARSE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL PREFERRED	
Logging	SUMMER IF AIMING FOR NATURAL REGEN. WINTER	
Site Prep.		
MSP	OK	
Prescribed Fire	AVOID	-moisture and nutrients concentrated in the soil organic horizons
Reforestation	PLANT PL IF REQUIRED	-rocky soils -for natural Pl have: 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Pl Acceptable: Sxw as a minor component; natural regeneration only Unacceptable: Bl
Logging	-natural regeneration: summer log with snipper cat and line skidders for optimum site disturbance
Site Prep.	
MSP	-probably only necessary following winter logging -can be used to reduce fire hazard instead of prescribed burning
Prescribed Fire	-can be detrimental to this ecosystem unit; can reduce soil productivity and moisture holding capacity -if required, the burn should remove only the litter (L) layer
Reforestation	-when planting on rocky soils plug stock would be best
Competing Vegetation	-not expected, unless disturbance is excessive

SBSe1/01.1(b): MESIC BUNCHBERRY - MOSS, BLACK HUCKLEBERRY SUBASSOCIATION: FINE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL PREFERRED	
Logging	WINTER	
	SUMMER	-possible soil compaction on fine textured soils
Site Prep.		
MSP	OK	-exposure of frequently occurring fine textured soil horizons
Prescribed Fire	USE WITH CARE	-soil organic horizons provide nutrient and moisture conservation
Reforestation	PLANT IF REQUIRED	-for natural Pl have: 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Pl Acceptable: Sxw as a minor component Unacceptable: Bl
Logging	-windfall potential for both Pl and Sxw when root restricting, structureless, fine textured or compact soils are near soil surface: adjust block layout -natural regeneration: summer log with snipper cat and line skidders for optimum site disturbance
Site Prep.	
MSP	-drag equipment adequate for providing planter access or exposed mineral soil for natural regeneration -if scraping or scalping sites with fine textured soil horizons, plant on the mounds rather than in the depressions or gouges
Prescribed Fire	-avoid when the soil organic horizons are less than 10 cm thick and Ah horizon is not present -otherwise burns that remove only the litter (L) layer OK

SBSe1/01.1(b) cont'd...

Reforestation	-possible frost heaving on noninsulated silty textured soils
Competing Vegetation	-not expected, unless disturbance is excessive -green alder may cause problems
Other Options	-establish a deep rooting ground cover that will break up the structureless, compact soil layers if present. This should provide better root penetration, moisture availability, and aeration for the tree seedlings

SBSel/01.2(a): MESIC BUNCHBERRY - MOSS, FIVE-LEAVED BRAMBLE SUBASSOCIATION: COARSE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL AND/OR SXW PREFERRED	
Logging	WINTER SUMMER	
Site Prep.		
MSP	OK	-slash
Prescribed Fire	OK (USE WITH CARE)	-soil organic horizons provide nutrient and moisture conservation
Reforestation	PLANT IF REQUIRED	may be competing vegetation - for natural PL (Sxw) have: 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Pl or Sxw; Pl favoured on well-drained sites Unacceptable: Bl
Logging	-natural regeneration: summer log with snipper cat and line skidders for optimum site disturbance
Site Prep.	
MSP	-when natural regeneration desired following winter logging, expect to prepare site -all machine types acceptable for providing planter access; choice will depend on size and quantity of slash
Prescribed Fire	-can be detrimental to this ecosystem unit; can reduce soil productivity and moisture holding capacity -if required, the burn should remove only the litter (L) layer
Reforestation	-when planting on rocky soils plugs would be best -if brush competition expected do not rely on natural regeneration; plant
Competing Vegetation	-could cause problems, especially if disturbance is excessive or if site is NSR for several years
Other Options	-Shelterwood or Seedtree regeneration systems

SBSe1/01.2(b): MESIC BUNCHBERRY - MOSS, FIVE-LEAVED BRAMBLE SUBASSOCIATION: FINE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW AND/OR PL PREFERRED	
Logging	WINTER; DURING DRY PERIODS SUMMER OK	-possible soil compaction on fine textured soils
Site Prep.		
MSP	OK	-slash -exposure of frequently occurring fine textured soil horizons
Prescribed Fire	ESTABLISH PL: OK ESTABLISH SXW: NOT RECOMMENDED	
Reforestation	PLANT IF REQUIRED	when competing veg. a problem, plant during first spring following last treatment -for natural Pl(Sxw) have: 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Sxw or Pl; Sxw favoured on moister sites Acceptable: Bl as minor component
Logging	-logging method will vary with timber size -windfall potential for both Pl and Sxw when root restricting, structureless, fine textured or compact soils are near soil surface; adjust block layout
Site Prep.	
MSP	-drag equipment adequate for providing planter access or exposing mineral soil for natural regeneration -if scraping or scalping sites with fine textured soil horizons plant on the mounds rather than in the depressions or gouges
Prescribed Fire	-if Ah horizon is not present: burning should remove no more than the litter (L) layer

SBSel/01.2(b) cont'd...

	-if Ah is present, ecologic impacts of fire are not as great a concern and burning may be desirable to create plantable spots
Reforestation	-if moderate brush competition expected do not rely on natural regeneration; plant -frost heaving possible on noninsulated silty textured soils -if Sxw is to be planted following prescribed fire it may be necessary to wait 1 year for shading vegetation to become established
Competing Vegetation	-moderate brush competition; mottling present within 50 cm of soil surface -low brush competition; mottling not present -brush competition will increase with increasing site disturbance
Other Options	-establish a deep rooting ground cover that will break up the structureless, compact soil layers if present. This should provide better root penetration, moisture availability, and aeration for the tree seedlings -Shelterwood or Seedtree regeneration systems

SBSe1/02: PINE - LICHEN
SBSe1/03: PINE - MOSS

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL PREFERRED	
Logging	SUMMER IF AIMING FOR NATURAL REGEN	-frequent thin soils over bedrock; severe disturbance results in site degradation
	WINTER	
Site Prep.		
MSP	OK	
Prescribed Fire	DO NOT BURN	-nutrients and moisture concentrated in the soil organic horizons
Reforestation	NATURAL REGEN, PL PLANT PL IF REQUIRED	-for natural Pl have: 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Pl Unacceptable: Sxw, Bl
Logging	-summer log when possible to provide disturbance for natural regeneration
Site Prep.	
MSP	-may be required -screefing may be adequate because of the thin organic horizons - depends on slash loading
Prescribed Fire	-do not burn; loss of organic matter on these sites will result in loss of site productivity
Reforestation	-these ecosystems are marginal for timber production -site should be naturally regenerated if possible -if planting, plugs may be necessary due to rocky soils
Competing Vegetation	-not expected
Other Options	-defer from logging

SBSel/04(a) and /04(b): SUBMESIC BUNCHBERRY - MOSS: COARSE AND FINE TEXTURED PHASES

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL PREFERRED	
Logging	SUMMER IF AIMING FOR NATURAL REGEN. WINTER	-increased susceptibility to windfall on fine textured phase
Site Prep.		
MSP	OK	
Prescribed Fire	DO NOT BURN	-nutrients and moisture concentrated in the soil organic horizons
Reforestation	PLANT PL IF REQUIRED	-rocky soils -for natural Pl have: 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Pl Unacceptable: Sxw, Bl
Logging	-natural regeneration: summer log with snipper cat and line skidders for optimum site disturbance
Site Prep.	
MSP	-should be used to reduce fire hazard instead of prescribed burning
Prescribed Fire	-do not burn; loss of organic matter on these sites will result in loss of site productivity
Reforestation	-when planting on rocky soils plug stock would be best
Competing Vegetation	-not expected

SBSel/05: PINE - BLACK SPRUCE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL PREFERRED	
Logging	WINTER; DURING DRY PERIODS SUMMER OK	-possible soil compaction on finer textured soils
Site Prep.		
MSP	OK	-exposure of fine textured surface soils
Prescribed Fire	OK	-except on sandy soil types
Reforestation	PLANT IF REQUIRED	-for natural Pl have: 1) adequate cones and viable seed; 2) adequate mineral soil exposure; 3) suitable climatic factors.

	COMMENTS
Species Choice	Preferred: Pl Acceptable: Sxw, Sb as minor components Unacceptable: Bl
Logging	-windfall potential for Pl, Sxw, and Sb
Site Prep.	
MSP	-if scraping or scalping sites with fine textured soil horizons, plant on the mounds rather than in the depressions or gouges
Prescribed Fire	-good way to reduce thick soil organic horizons that accumulate in the older stands
Reforestation	-aim for natural regeneration of Pl where possible
Competing Vegetation	-not expected

SBSe1/06: MOIST THIMBLEBERRY - FORB

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL AND/OR SXW PREFERRED	
Logging	WINTER; DURING DRY PERIODS SUMMER OK	-slope -possible soil compaction on fine textured soils
Site Prep.		
MSP	OK	-may increase brush competition -exposure of occasionally occurring fine textured soil horizons
Prescribed Fire	OK	-colluvial landforms
Reforestation	PLANT SXW, PL	-competing vegetation; plant during first spring following last treatment -occasional thick soil organic horizons

	COMMENTS
Species Choice	Preferred: Sxw; Pl favoured on well-drained sites Acceptable: Bl as a minor component
Logging	-logging method will depend on slope and timber size
Site Prep.	
MSP	-good alternative for providing planter access on sites where burning is undesirable -if scraping or scalping sites with fine textured soil horizons, plant on the mounds rather than in the depressions or gouges
Prescribed Fire	-avoid on colluvial landforms; can cause accelerated erosion -if Ah horizon is not present, burning should remove no more than the litter (L) layer -if Ah is present, ecologic impacts of fire are not as great a concern and burning may be desirable to create plantable spots -may be OK regardless if Bt not too deep

SBSel/06 cont'd...

Competing Vegetation	-moderate to high potential for brush competition -deciduous trees often present; try to minimize sprouting and suckering
Stand Tending	-plan to reduce brush competition to maintain the plantation -assess at time of planting
Other Options	-cable logging systems could be used on steeper slopes -uneven age management -fair potential for native range or tame pasture

SBSe1/07(a): OAK FERN: COARSE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	PL AND/OR SXW PREFERRED	
Logging	WINTER; DURING DRY PERIODS SUMMER OK	-may increase brush competition
Site Prep.		
MSP	OK	-may increase brush competition -occasional steep slopes
Prescribed Fire	OK	-colluvial landforms and/or podzolic soil types
Reforestation	PLANT PL, SXW	-competing vegetation; plant during first spring following last treatment -occasional thick soil organic horizons

	COMMENTS
Specie Choice	Preferred: Pl, Sxw Acceptable: Bl
Logging	-mostly winter, occasionally summer - during summer try a wide-tracked Cat or FMC
Site Prep.	
MSP	-good alternative to burning for providing planter access
Prescribed Fire	-if Ah horizon is not present, burning should remove no more than the litter (L) layer; this generally occurs on colluvial landforms and/or podzolic soil types -if Ah is present, ecologic impacts of fire are not as great a concern and burning may be desirable to create plantable spots
Reforestation	-plant sturdy, vigourous stock -may have to screef
Competing Vegetation	-moderate potential for brush competition; if site severely disturbed expect high brush competition -aspen can cause problems
Stand Tending	-plan to reduce brush competition to maintain the plantation
Other Options	-uneven age management

SBSel/07(b): OAK FERN: FINE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW AND/OR PL PREFERRED	
Logging	WINTER; DURING DRY PERIODS SUMMER OK	-possible soil compaction or erosion on fine textured soils -may increase brush competition
Site Prep.		
MSP	OK	-exposure of occasionally occurring fine textured soil horizons -may increase brush competition -occasional steep slopes
Prescribed Fire	OK	
Reforestation	PLANT SXW, PL	-competing vegetation; plant during first spring following last treatment -occasional thick soil organic horizons

	COMMENTS
Species Choice	Preferred: Sxw, Pl Acceptable: Bl
Logging	-mostly winter, occasionally summer - during summer try a wide-tracked Cat or FMC
Site Prep.	
MSP	-good alternative to burning for providing planter access -if scraping or scalping sites with fine textured soil horizons, plant on the mounds rather than in the depressions or gouges
Prescribed Fire	-if Ah horizon is not present, burning should remove no more than the litter (L) layer -if Ah is present, ecologic impacts of fire are not as great a concern and burning may be desirable to create plantable spots

SBSe1/07 (b) cont'd...

Competing Vegetation	-moderate potential for brush competition; if site severely disturbed expect high brush competition -aspen can cause problems
Stand Tending	-plan to reduce brush competition to maintain the plantation
Other Options	-uneven age management

SBSe1/08(a): DEVIL'S CLUB: COARSE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW AND/OR PL PREFERRED	
Logging	WINTER; SUMMER (IN DRY PERIODS)	-exposure of mineral soil will increase brush potential
Site Prep.		
MSP	PATCH SCARIFY	-excessive mineral soil exposure will increase brush potential -slope -slash
Prescribed Fire	OK	
Reforestation	PLANT SXW OR PL	-competing vegetation -thick soil organic horizons

	COMMENTS
Species Choice	Preferred: Sxw, Pl Acceptable: Bl
Site Prep.	
MSP	-sites may be too steep -patch scarify to create sufficient plantable spots with least mineral soil exposure
Prescribed Fire	-no problem in maintaining site productivity -will temporarily reduce brush problem
Reforestation	-plant on edge of scarified patch -plant sturdy vigourous stock -screefing may be necessary
Competing Vegetation	-high potential for brush competition (may be higher than the fine textured phase)
Stand Tending	-plantation maintenance probably necessary to reduce brush

SBSe1/08(b): DEVIL'S CLUB: FINE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW PREFERRED	
Logging	WINTER	
Site Prep.		
MSP	CREATE MOUNDS FOR PLANTING	-slope -slash -may increase brush competition -high water table may be present -exposure of fine textured soil horizons may occur
Prescribed Fire	OK	
Reforestation	PLANT SXW	-competing vegetation; plant immediately -thick soil organic horizons

	COMMENTS
Species Choice	Preferred: Sxw Acceptable: Bl (Pl) sites usually too wet for Pl
Site Prep.	
MSP	-sites will often be too wet or too steep for MSP -patch scarify to obtain plantable spots with least overall soil disturbance
Prescribed Fire	-no problem in maintaining site productivity -will temporarily reduce brush problem
Reforestation	-plant on mounds, not in depressions -plant sturdy vigourous stock -screefing may be necessary
Competing Vegetation	-high brush potential
Stand Tending	-plantation maintenance probably necessary to reduce brush problem

SBSel/09(a): HORSETAIL FLAT: COARSE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW PREFERRED	
Logging	SUMMER	-disturbance of soil organic horizons may accelerate soil erosion on active floodplains
	WINTER	
Site Prep.		
MSP	OK	-slash
Prescribed Fire	NOT RECOMMENDED	-could accelerate soil erosion on active floodplains
Reforestation	PLANT SXW IMMEDIATELY	-competing vegetation -flooding

	COMMENTS
Species Choice	Preferred: Sxw Acceptable: Pl, (Bl)
Logging	-summer logging: avoid skidders to reduce excessive soil disturbance -cat yarding good for knocking down brush and minimizing excessive soil disturbance -MSP should not be required -winter logging: MSP probably required to facilitate planting
Site Prep.	
MSP	-to produce plantable spots; method depends on amount of slash
Prescribed Fire	-soils are generally coarse textured; soil organic horizons are generally thin (1-5 cm); organic horizons should be maintained to protect the sites from erosion damage during flooding
Reforestation	-plant tall large-caliper stock -if summer logged; plant that fall or next spring -if winter logged; plant first spring or fall following last treatment
Competing Vegetation	-expect high to extreme brush competition; mainly shrubs and deciduous trees

SBSel/09(a) cont'd...

Stand Tending	-plan to reduce brush competition to maintain the plantation
Other Options	-Selection regeneration system -cottonwood would become an acceptable species on well-drained sites if and when it becomes a commercial species

SBSel/09(b): HORSETAIL FLAT: FINE TEXTURED PHASE

ACTIVITY	PRESCRIPTION	CAUTIONS
Species Selection	SXW PREFERRED	
Logging	WINTER	
Site Prep.		
MSP	PROBABLY BENEFICIAL BUT USUALLY NOT FEASIBLE	-high water table -slash
Prescribed Fire	BENEFICIAL BUT DIFFICULT	-wet conditions throughout the year
Reforestation	PLANT SXW IMMEDIATELY	-competing vegetation -thick soil organic horizons -high water table

	COMMENTS
Species Choice	Preferred: Sxw Acceptable: Bl, (Pl) sites usually too wet for Pl
Logging	-methods depend on site and timber conditions
Site Prep.	
MSP	-has potential; MSP must produce raised areas for planting; seedlings established on mounds should have a competitive advantage -sites will often be too wet for equipment use
Prescribed Fire	-burning no problem in terms of maintaining site productivity -should improve site plantability; may reduce brush competition for a year, but increase brush competition later
Reforestation	-plant tall large-caliper stock -thick organic layers could pose problems without site preparation
Competing Vegetation	-expect high to extreme brush competition; mainly shrubs and deciduous trees
Stand Tending	-plan to reduce brush competition to maintain the plantation
Other Options	-Selection regeneration system

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APPENDIX 1

List of Plant Names Used in the Guide

Abies lasiocarpa	subalpine fir
Achillea millefolium	yarrow
Actaea rubra	baneberry
Agropyron trachycaulum	slender wheat grass
Allium cernuum	nodding wild onion
Alnus incana	speckled alder
Alnus viridis	green alder
Amelanchier alnifolia	Saskatoon
Anemone multifida	Pacific anemone
Aralia nudicaulis	false sarsaparilla
Arctostaphylos uva-ursi	kinnikinnick
Arnica cordifolia	heartleaved arnica
Aster ciliolatus	fringed aster
Aster conspicuus	showy aster
Aster modestus	great northern aster
Athyrium filix-femina	lady fern
Aulacomnium palustre	
Barbilophozia lycopodioides	
Betula glandulosa	scrub birch
Betula papyrifera	paper birch
Brachythecium	
Brachythecium hylotapetum	
Brachythecium rutabulum	
Brachythecium salebrosum	
Bromus anomalus	nodding brome
Bromus carinatus	California brome
Calamagrostis canadensis	bluejoint
Calamagrostis rubescens	pinegrass
Calliergon	
Calliergon cordifolium	
Calliergon stramineum	
Carex aquatilis	water sedge
Carex disperma	soft-leaved sedge
Carex limosa	shore sedge
Carex macloviana	thick-headed sedge
Carex pauciflora	few-flowered sedge
Carex rostrata	beaked sedge
Castilleja	Indian paintbrush
Chimaphila umbellata	pipsissewa
Cladina arbuscula	
Cladina mitis	
Cladina rangiferina	reindeer lichen
Cladonia chlorophaea	pixie-cup lichen
Cladonia ecmocyna	
Cladonia gracilis	
Clintonia uniflora	queen's cup
Cornus canadensis	bunchberry

Cornus sericea	red-osier dogwood
Danthonia californica	California oat grass
Delphinium glaucum	glaucous delphinium
Deschampsia caespitosa	tufted hair grass
Descurainia pinnata	western tansy mustard
Dicranum fuscescens	
Dicranum polysetum	
Disporum trachycarpum	rough-fruited fairybells
Drepanocladus	
Drepanocladus exannulatus	
Drepanocladus uncinatus	
Dryopteris assimilis	spiny wood fern
Elymus glaucus	blue wild rye
Empetrum nigrum	crowberry
Epilobium angustifolium	fireweed
Equisetum arvense	common horsetail
Equisetum fluviatile	swamp horsetail
Equisetum pratense	meadow horsetail
Equisetum sylvaticum	wood horsetail
Eriophorum brachyantherum	cotton-grass
Eriophorum vaginatum	cotton-grass
Festuca occidentalis	western fescue
Fragaria virginiana	strawberry
Galium boreale	northern bedstraw
Galium triflorum	creeping sweet bedstraw
Gaultheria hispidula	creeping-snowberry
Geocaulon lividum	bastard toadflax
Geranium richardsonii	white geranium
Gymnocarpium dryopteris	oak fern
Heracleum sphondylium	cow-parsnip
Hylocomium splendens	stepped feather moss
Icmadophila ericetorum	
Juncus arcticus	arctic rush
Juniperus communis	common juniper
Juniperus scopulorum	Rocky Mountain juniper
Koeleria macrantha	June grass
Lathyrus nevadensis	purple peavine
Lathyrus ochroleucus	creamy peavine
Ledum groenlandicum	Labrador tea
Linnaea borealis	twinflower
Lonicera involucrata	black twinberry
Lycopodium annotinum	stiff club-moss
Melampyrum lineare	cow-wheat
Menziesia ferruginea	rusty false azalea
Mitella nuda	creeping mitrewort
Mnium	
Mnium glabrescens	
Mnium insigne	
Mnium medium	
Nuphar lutea ssp. polysepala	yellow pond-lily
Oplopanax horridus	devil's club

Orthilia secunda	one-sided wintergreen
Oryzopsis asperifolia	rough-leaved rice grass
Oryzopsis pungens	short-awned rice grass
Osmorhiza chilensis	sweetcicely
Paxistima myrsinites	false box
Peltigera aphthosa	
Peltigera malacea	
Petasites palmatus	palmate colt's-foot
Phleum pratense	timothy
Picea engelmannii	Engelmann spruce
Picea glauca	white spruce
Picea glauca x engelmannii	hybrid spruce
Picea mariana	black spruce
Pinus contorta	lodgepole pine
Pleurozium schreberi	red-stemmed feather moss
Poa gracillima	Pacific blue grass
Poa interior	inland blue grass
Poa pratensis	Kentucky blue grass
Polytrichum commune	moss, hair cap
Polytrichum juniperinum	
Populus balsamifera ssp. trichocarpa	black cottonwood
Populus tremuloides	trembling aspen
Potamogeton	pondweed
Potentilla palustris	marsh cinquefoil
Prunus virginiana	choke cherry
Pseudotsuga menziesii var. glauca	Douglas-fir
Ptilidium ciliare	
Ptilium crista-castrensis	knight's plume feather moss
Pyrola asarifolia	rosy wintergreen
Pyrola chlorantha	green wintergreen
Rhytidiadelphus triquetrus	electrified cat's-tail moss
Rhytidiopsis robusta	pipe-cleaner moss
Ribes lacustre	black gooseberry
Ribes oxyacanthoides	cream-flowered gooseberry
Rosa acicularis	prickly rose
Rubus chamaemorus	cloudberry
Rubus parviflorus	thimbleberry
Rubus pedatus	five-leaved bramble
Rubus pubescens	trailing raspberry
Salix barclayi	Barclay's willow
Salix bebbiana	Bebb's willow
Salix brachycarpa	short-fruited willow
Salix drummondiana	Drummond's willow
Salix glauca	grey-leaved willow
Salix maccalliana	Maccall's willow
Salix pedicellaris	bog willow
Salix scouleriana	Scouler's willow
Sanguisorba canadensis ssp. latifolia	Sitka burnet

Schizachne purpurascens	false melic
Shepherdia canadensis	soopolallie
Smilacina racemosa	false Solomon's-seal
Smilacina stellata	star-flowered false Solomon's-seal
Sphagnum	peat moss
Sphagnum capillaceum	
Sphagnum fuscum	
Sphagnum girgensohnii	
Sphagnum magellanicum	
Sphagnum recurvum	
Spiraea betulifolia	birch-leaved spirea
Spiraea douglasii	hardhack
Stereocaulon tomentosum	
Stipa occidentalis var. *minor*	stiff needle grass
Stipa richardsonii	spreading needle grass
Streptopus amplexifolius	clasping-leaved twistedstalk
Streptopus roseus	rosy twistedstalk
Symphoricarpos albus	snowberry
Taraxacum officinale	dandelion
Thalictrum occidentale	western medow-rue
Tiarella trifoliata	three-leaved foamflower
Tomenthypnum nitens	
Tortula ruralis	
Vaccinium caespitosum	dwarf blueberry
Vaccinium membranaceum	black huckleberry
Vaccinium ovalifolium	oval-leaved blueberry
Vaccinium oxycoccos	bog cranberry
Viburnum edule	highbush-cranberry
Vicia americana	American vetch
Viola canadensis	Canada violet

APPENDIX 2

Tree Species Symbols Used in the Guide.

Genus	Species or Hybrid	Genus Symbol	Species or Hybrid Symbol
Abies balsam	A. lasiocarpa (subalpine fir)	B	Bl
Betula birch	B. papyrifera (paper birch)	E	Ep
Picea spruce	P. glauca (white spruce)	S	Sw
	P. glauca x engelmannii (hybrid white spruce)		Sxw
	P. mariana (black spruce)		Sb
Pinus pine	P. contorta (lodgepole pine)	P	Pl
Populus poplar	P. balsamifera ssp. trichocarpa (black cottonwood)	A	Act
	P. tremuloides (trembling aspen)		At
Pseudotsuga fir	P. menziesii var. glauca (Douglas-fir)	F	Fd

APPENDIX 3

GLOSSARY

ablation till - a surface deposit of loose, permeable, somewhat stratified, sandy and stoney till overlying dense till. It was deposited when areas of stagnant/dead ice melted at slower rates than the surrounding ice mass.

Ah - a surface or near-surface mineral horizon of organic matter accumulation. It contains less than 17% organic carbon. It is one Munsell unit of colour value darker than the layer immediately below, or it has at least 0.5% more organic carbon than the 1C horizon, or both.

association, plant - an abstract concept comprising all climax stands of vegetation (or plant communities) in which the dominant species of corresponding layers are essentially the same.

basal till - an unsorted, unstratified mixture of sand, silt, clay, and coarser fragments deposited by ice without additional transportation by water.

biogeoclimatic phase - a significant, extensive area of ecosystems that is, for topographic or topoedaphic reasons, atypical for the regional climate; i.e., a phase reflects local climate.

biogeoclimatic subzone - a subdivision of a zone characterized by a distinct climatic climax or zonal ecosystem association described in terms of vegetation and soil. It consists of unique sequences of geographically related ecosystems in which climatic climax ecosystems are members of the same ecosystem association.

biogeoclimatic variant - a subdivision of a subzone based on differences in regional climate. It is characterized by a distinct zonal ecosystem association plus a supplementary combination of environmental factors (vegetation, soil, ecosystem productivity).

biogeoclimatic zone - a large geographic area that has a broadly homogeneous mesoclimate and exhibits similar patterns of soil and vegetation. It is made up of closely related subzones, and is characterized by a group of closely related, zonal ecosystem associations.

bog - a wetland covered or filled with poorly to moderately decomposed *Sphagnum*-derived peats. It is strongly acid and low in nutrients.

circumboreal - occurring at once in the northern parts of North America, Asia, and Europe.

climax, types of:

climatic - an equilibrium condition of an ecosystem that reflects the development potential of the mesoclimate or regional climate of an area. It is characterized by a zonal or mesic ecosystem.

edaphic - differs from the climatic climax as a result of overriding soil or substrate conditions.

fire - results from recurrent wildfire.

topographic - reflects the effects of topography on local or microclimate.

colluvial - unconsolidated materials deposited by mass wasting (direct gravitational action) on or at the base of steep slopes. The materials usually consist of coarse, angular, fractured bedrock, but the bedrock fragments may also be mixed or associated with redistributed glacial till.

community, plant - an area of relatively uniform vegetation. An assemblage of populations of plants, forming a system of organisms living together and linked by their effects on one another and their responses to the environment they share.

drift - glacial deposits.

drumlin - low, smooth, elongated, oval hill, mound or ridge of compact glacial till that may consist entirely of till or have a core of bedrock. It is deposited by glacier ice and has its long axis parallel to the direction of ice movement.

ecosystem - a portion of the landscape and the life on and in it, or a community and its environment treated together. For our purposes: a plant community plus the soil polypedon on which it occurs.

ecosystem association - all ecosystems (land areas plus their biota) capable of producing vegetation belonging to the same plant association at climax.

ecosystem, mesic - the expression of intermediate or medium moisture and nutrient conditions for a particular, geographical area. Synonymous with 'zonal' or 'climatic climax'.

ecosystem phase - a subdivision of an ecosystem association (or subassociation) based on contrasting soil or landform characteristics, such as soil texture, slope classes, aspect, parent materials, bedrock geology, or soil climate.

ecosystem subassociation - a subdivision of an ecosystem association based on differences in species composition that appear to reflect edaphic trends or long-term successional factors, but that are not considered significant enough to warrant the recognition of a separate association.

ecosystem type - all land areas capable of producing vegetation belonging to the same plant association at climax on soil of a single soil family.

ecosystem, variation - a subdivision of an ecosystem association used to describe vegetative trends or floristic features that diverge somewhat from the central concept of the association. It may be used to describe successional stages or variation in stand structure, species composition, understory features, etc.

ecosystem, zonal - the ecosystem that best reflects the regional climate. Synonymous with 'mesic' and 'climatic climax' ecosystem.

edaphic - of or relating to the soil.

edatope - the physical component of an ecosystem; more or less synonymous with habitat.

edatopic grid - a graphic display of the range of moisture and nutrient conditions over which an ecosystem unit or plant develops, with the ecological moisture regime on the vertical axis and the ecological nutrient regime on the horizontal axis.

ericaceous - belonging to the Ericaceae or heather family of flowering plants.

esker - a winding ridge of irregularly stratified sand, gravel, and cobbles deposited under the ice by a rapidly flowing glacial stream.

evapotranspiration - the loss of water from a given area during a specified time by evaporation from the soil surface and by transpiration from the plants.

fabric - the physical constitution of a material, in this case the humus.

fen - a wetland comprised of accumulations of well to poorly decomposed non-Sphagnic peats. Fens are less acid and more mineral-rich than are bogs.

fluted landform - areas of till that have surfaces of straight parallel grooves separated by ridges.

fluvial - of or pertaining to rivers; produced by river action, as a fluvial plain.

fluvioglacial (= glaciofluvial, fluvialglacial) see 'glaciofluvial'.

forb - a herb other than a grass, sedge, or other plant with similar foliage.

fragic - a Bx or BCx horizon of high bulk density and consistence that is firm and brittle when moist and hard to extremely hard when dry.

fruticose - a lichen growth form, shrubby or hairlike.

glacial outwash - stratified sand and gravel produced by glaciers and carried, sorted, and deposited by water that originated mainly from the melting of glacial ice.

glacial till - unsorted and unstratified glacial drift, generally unconsolidated, deposited directly by a glacier without subsequent reworking by water from the glacier, and consisting of a heterogeneous mixture of clay, sand, gravel, and boulders varying widely in size and shape.

glaciofluvial (= fluvialglacial, fluvioglacial) - refers to material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces.

glaciolacustrine - refers to material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting of glacial ice.

gleyed, gleying - a soil-forming process, operating under poor drainage conditions, that results in the reduction of iron and other elements and in gray colours and mottles.

ground moraine, low relief - areas of basal till where bedrock exerts no control on the surface topography, characteristically with low-relief, subdued surfaces.

growing degree days - the difference between the mean daily temperature and a selected standard temperature (e.g., 5°C or 10°C), accumulated daily over a period of time such as the growing season or a calendar year.

humus - the complex organic products of the decomposition of plant or animal debris. These materials are more stable than their precursors, and are generally dark in colour, colloidal, and commonly associated with mineral constituents in soil.

kame - a glaciofluvial landform that generally takes the form of a conical, steep-sided hill or short ridge. It is composed of moderately sorted sands or gravels.

lacustrine - refers to material deposited in lake water and later exposed either by lowering of the water level or by uplifting of the land. These sediments range in texture from sands to clays.

marsh - a wetland that is permanently or seasonally inundated with nutrient-rich water, and that supports extensive cover of emergent herbaceous vegetation rooting in mineral-rich substrate.

mesic - intermediate or medium moisture conditions; that is, neither very wet nor very dry. The term refers to habitats that have neither an excess nor a shortage of water, relative to the existing extremes in a given area.

mesoclimate - the prevailing or regional climate, corresponding in extent to major landforms or geographic areas; what many ecologists (but not climatologists) perceive as macroclimate.

minerotrophic - nourished by mineral water; refers to wetlands that receive nutrients from mineral ground water.

moder - a zoogenous forest humus form made up of plant remains partly disintegrated by the soil fauna (F layer); generally not matted as in mors; mineral grains may permeate organic horizons; insect droppings are common.

mor (raw humus) - a nonzoogenous forest humus form; commonly acidic; distinguished by a matted F layer; fungal mycelia are common.

morainal - refers to materials deposited directly from glacial ice. Sediments are generally compact, non-sorted and non-stratified and contain a heterogeneous mixture of particle sizes. Fragments are typically slightly rounded to somewhat angular. (Synonymous with 'glacial till').

morainal blankets - mantles of morainal material that are greater than 1m in depth. They are closely associated with long, smooth, bedrock-controlled slopes.

morainal till - non-sorted and non-stratified glacial stony clay accumulated chiefly by the direct action of glacial ice.

morainal veneers - shallow (often discontinuous) mantles of morainal material less than 1m thick. They occur upslope, on bedrock knobs, or in other locations where bedrock frequently outcrops.

mottling - formation or presence of spots or blotches of different colour or shades of colour interspersed with the dominant colour of the soil.

mull - a zoogenous forest humus form consisting of a mixture of well-humified organic matter and mineral soil that makes a gradual transition to the horizon underneath. It is distinguished by a granular structure. Because of the activity of the burrowing microfauna (mostly earthworms), partly decomposed organic debris does not accumulate as a distinct layer (F layer) as in mor and moder. Found primarily in grasslands.

orographic - of or relating to mountains; associated with or induced by the presence of mountains.

orthic - true; of or pertaining to the central concept.

pedon - the smallest unit or volume of soil that represents all the horizons of the soil profile. It is usually about one cubic meter, but can be larger.

polypedon, soil - a volume of relatively uniform soil; made up of more than one pedon.

potential evapotranspiration (PET) - the evaporation from an extended surface of short green crop that fully shades the ground, exerts little or negligible resistance to the flow of water, and is always well-supplied with water. Potential evapotranspiration cannot exceed free water evaporation under the same weather conditions. PET is a function of the amount of solar radiation available, the humidity, and the surrounding air temperature.

proglacial outwash - applied to deposits made by meltwater streams beyond the limits of the glacier.

savanna - a type of vegetation in which tall, widely spaced plants, especially trees, are scattered individually over land otherwise covered with low-growing plants, especially grasses.

scrub - woody vegetation dominated by shrubs.

seral stage - non climax, successional stage in the development of an ecosystem.

serotiny - late in developing; a term used mainly for the cones of those conifers that remain closed for a year or more after the seeds within are fully mature.

shield volcano - a broad, gently sloping volcanic cone of flat dome-like shape, usually several tens or hundreds of square kilometers in extent, built chiefly of overlapping and interfingering basaltic lava flows.

shrub-carr - low shrub-dominated wetland developed on mineral materials that are periodically saturated but rarely inundated. Note: in British literature, a waterlogged woodland (shrubs or trees).

soil family - a category in the Canadian system of soil classification. Differentiae are primarily texture, drainage, thickness of horizons, permeability, mineralogy, consistence, and soil climate.

soil polypedon - a volume of relatively uniform soil.

solum - the upper horizons of a soil in which the parent material has been modified and in which most plant roots are contained. It usually consists of A and B horizons.

steppe - open grass or other herbaceous vegetation, the plants or tufts discrete but averaging less than their diameters apart.

succession, ecological - the progression of ecosystems through time.

successional stage - a step in the progressive development of an ecosystem.

swamp - wooded wetland dominated by 25% or greater cover of trees or tall shrubs, and characterized by periodic flooding and nearly permanent subsurface water flow through various mixtures of mineral sediments and peat. Swamps are rich in minerals and nutrients and with the characteristic water movement are sufficiently aerated to support either tall shrubs or trees.

topoedaphic - of or pertaining to a combination of topography and soil.

wetlands - wetlands are lands that are wet enough or inundated frequently enough to develop and support a distinctive natural vegetative cover that is in strong contrast to the adjacent matrix of better drained lands.

zonal - representative of the mesoclimate or prevailing regional climate of an area. Synonymous with 'climatic climax' and 'mesic'.